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NASA SUPPORT MANUAL

APOLLO SPACECRAFT DESCRIPTION BOILERPLATE 13

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INTRODUCTION

This manual pertains to the mission, and provides physical and operational descriptions of boilerplate 13, part No. B14-000002-171, manufactured by Space and Information Systems Division of North American Aviation, Inc., Downey, California. Supporting documentation and ground support equipment is described in general terms. Functional schematics and block diagrams are also included in this manual. The applicability of this manual is listed in the Index of Apollo Support Manuals and Procedures, SM1A-1.

SECTION I

MISSION AND OBJECTIVES

1-1. PURPOSE.

1-2. This section describes the mission and objectives of boilerplate 13 (figure 1-1). A mission profile is shown in figure 1-2.

1-3. BOILERPLATE 13 MISSION.

1-4. The Apollo-Saturn compatibility tests have the initial objectives of developing and qualifying the spacecraft and systems to be used for manned earth-orbital flight. The unmanned boilerplate 13 configuration is the first of these launch vehicle and spacecraft compatibility tests. This test will also serve to demonstrate certain environmental and systems compatibilities. Boilerplates are research and development vehicles which simulate production spacecraft in size, shape and structural soundness. Boilerplate 13 is equipped with instrumentation to record mission parameter data for engineering review and evaluation. The data gained from testing of boilerplate configurations will be used in determining production spacecraft flight parameters.

1-5. APOLLO FIRST ORDER TEST OBJECTIVES.

1-6. The following are the primary test objectives of the boilerplate 13 flight test:

a. Demonstrate the physical compatibility of the launch vehicle and spacecraft under preflight and flight conditions.

b. Determine the launch and exit environmental parameters for verification of design criteria.

1-7. APOLLO SECOND ORDER TEST OBJECTIVES.

1-8. The following are the secondary test objectives of the boilerplate 13 flight test:

a. Demonstrate the structural integrity of the launch escape system under flight loading conditions.

b. Demonstrate satisfactory launch escape tower jettison.

c. Demonstrate compatibility of the R&D communications and instrumentation systems with launch vehicle systems.

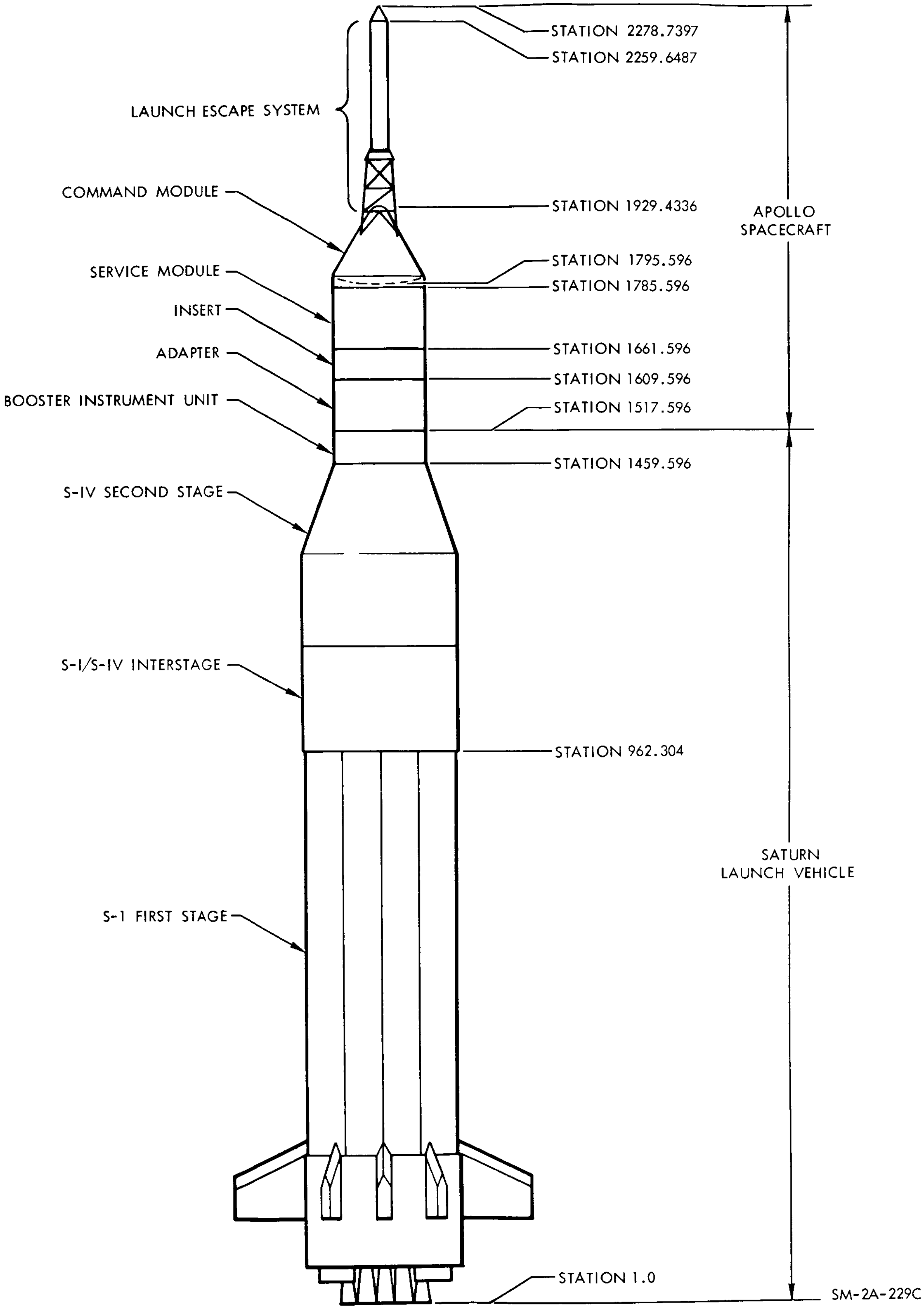
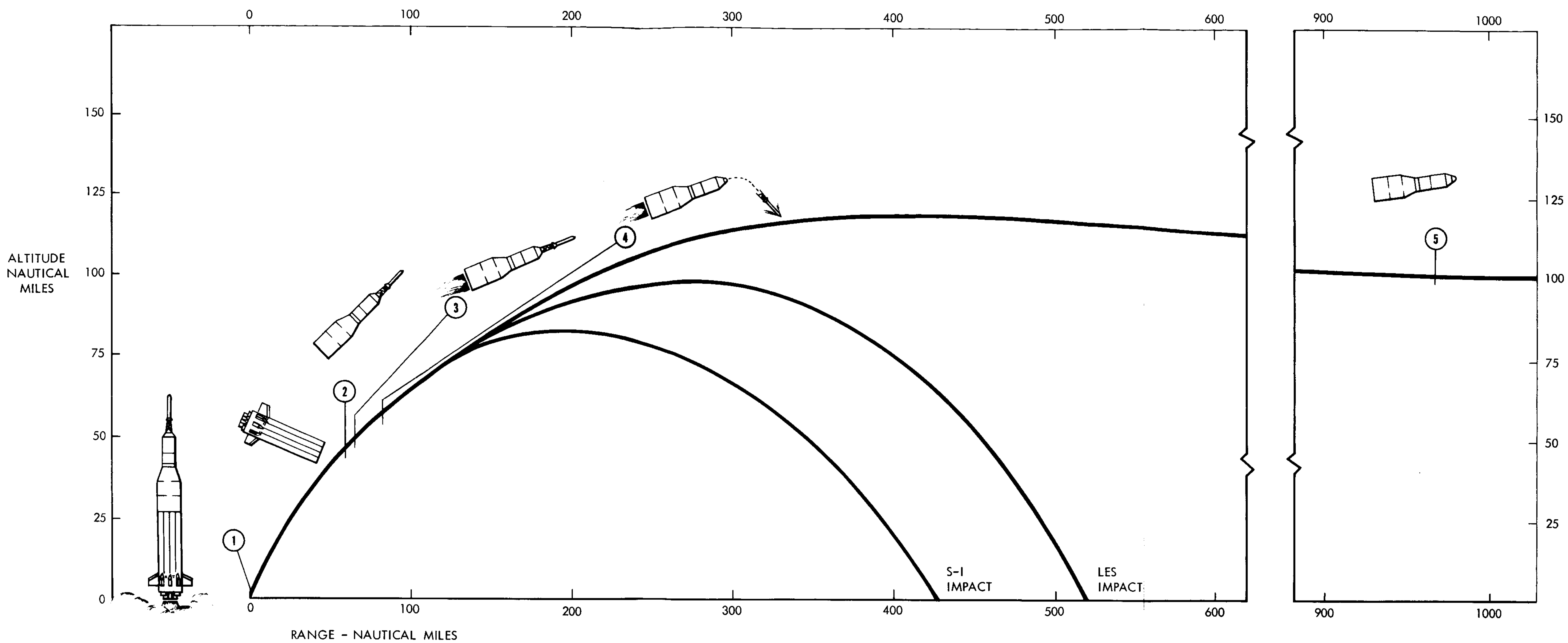


Figure 1-1. Booster Compatibility Space Vehicle



SEQUENCE OF MAJOR EVENTS

1 LAUNCH (LIFT-OFF):
2 S-I BURNOUT AND SEPARATION
3 S-IV IGNITION
4 LES JETTISON
5 S-IV BURNOUT AND ORBIT INJECTION

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Figure 1-2. Flight Sequence and Trajectory

SECTION II

PHYSICAL DESCRIPTION

2-1. PURPOSE.

2-2. This section contains a physical description of the launch escape system, command module, service module, insert, and adapter. The boilerplate 13 spacecraft, mounted on a Saturn I launch vehicle, comprises the complete test vehicle. (See figure 1-1.)

2-3. LAUNCH ESCAPE ASSEMBLY.

2-4. Structural relationships and physical location of the components of the assembly are shown in figure 2-1. Pertinent physical characteristics are contained in table 2-1.

Table 2-1. Launch Escape Assembly Physical Characteristics

Overall Dimensions:	
Length	33 feet
Weight	6600 pounds (approx)
Tower Structure:	
Length	118 inches
Width (top of tower)	36 inches
Width (bottom of tower)	50.6 inches
Weight	533 pounds (approx)
Structural Skirt:	
Length	18.25 inches
Diameter	48.8 inches
Weight	227 pounds
Launch Escape Motor:	
Length	185.3 inches
Diameter at nozzle exit	28 inches
Diameter of motor structure	26 inches
Weight	4809 pounds (approx)

Table 2-1. Launch Escape Assembly Physical Characteristics (Cont)

Tower Jettison Motor:	
Length	55.6 inches
Diameter at nozzle exit	28 inches
Diameter of motor structure	26 inches
Weight	529 pounds (approx)
Pitch Control Motor Structure:	
Length (includes ballast and motor structure)	18.62 inches
Diameter	26 inches
Weight	158 pounds (approx)
Pitch Control Motor:	
Length	22 inches
Diameter of body	8.79 inches
Diameter of flange	10.51 inches
Weight	47 pounds (approx)
Ballast:	
Diameter of lead discs	20.5 inches
Thickness	1.13 inches
Weight	189 pounds (approx)
Ballast Enclosure:	
Length	29 inches
Diameter (forward end)	13.1 inches
Diameter (aft end)	26 inches
Weight	73 pounds (approx)
Nose Cone (Q-Ball):	
Length	19.09 inches
Diameter (forward end)	2 inches
Diameter (aft end)	13.03 inches
Weight	22 pounds (approx)

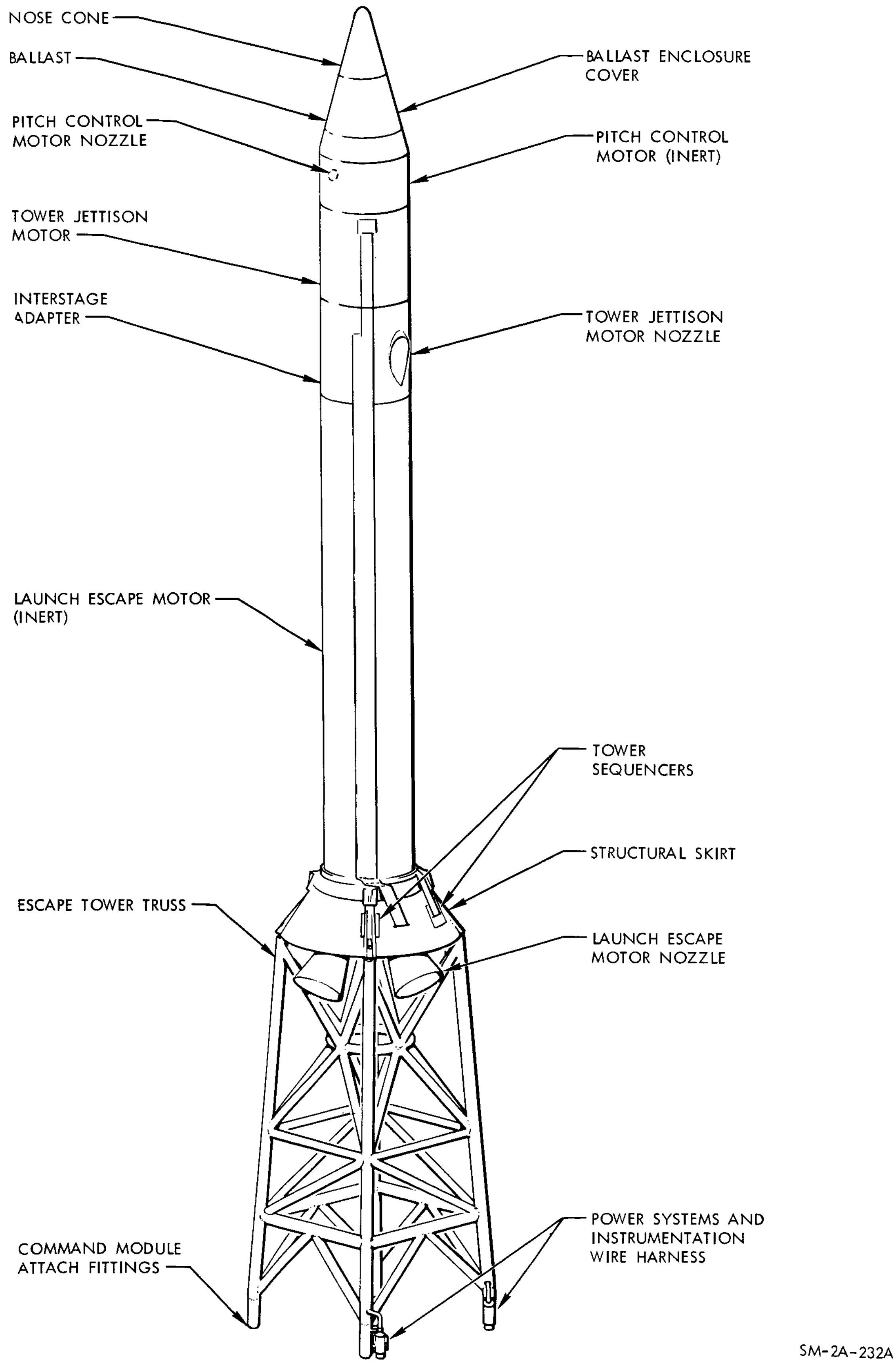

Figure 2-1. Launch Escape Assembly

2-5. STRUCTURE. The truss-type tower structure is the base of the launch escape assembly. It is an open frame of welded titanium tubing covered with silica-filled Buna-N rubber for thermal insulation. Each of the four legs is attached to the command module by an explosive bolt. (See figure 2-2.) Attachments at the top of each tower leg facilitate tower alignment. (See figure 2-3.) The structural skirt is attached between the top of the tower structure and the base of the launch escape motor. The housing of the launch escape motor forms the structure between the structural skirt and the interstage structure. The interstage structure (figure 2-4), is a welded-cylindrical structure which houses the tower jettison motor exhaust nozzles and various electrical components. Two access doors facilitate installation and removal of the components. The ballast housing and the nose cone are of welded Inconel sheet construction, and are bolted together to form a single conical structure to house the sheet lead ballast. (See figure 2-5.) The Q-Ball replaces the nose cone when installed. (See figure 4-3.)

2-6. LAUNCH ESCAPE SYSTEM MOTORS. The three launch escape system motors are stacked above the tower structure. Boilerplate 13 launch escape motor and pitch control motor are inert. The tower jettison motor utilizes a star-grain solid propellant of a polysulfide ammonium perchlorate formulation. The jettison motor has two fixed nozzles. Passive thrust vector control is used to obtain proper jettison trajectories.

2-7. LAUNCH ESCAPE SYSTEM ELECTRICAL AND ELECTRONIC COMPONENTS. The electrical and electronic components in the launch escape system consist of launch escape sequencers (contained in the command module and on the structural skirt), hot wire initiators, and associated wiring harnesses and attachements. Redundant wiring harnesses are bonded to the exterior of the launch escape motor, and associated redundant harnesses are integral to the tower structure. Each tower structure harness has a breakaway plug that allows the harness to detach itself from the command module when the launch escape tower is jettisoned. The wiring harnesses provide the means of connecting the rocket motor and separation circuits with the sequence controllers, and the instrumentation components with the communications equipment.

2-8. SEQUENCERS. Three sequencers are provided to program the sequence of events during the mission. Two tower sequencers located on the structural skirt are identical in size and shape. Each tower sequencer is approximately 2.5 inches in width, 8.25 inches deep, and 3.75 inches high. See figure 2-3 for location. A mission sequencer is installed in the command module. The mission sequencer is a single-enclosed assembly approximately 15 inches wide, 8.25 inches deep, and 7 inches high. See figure 2-7.

2-9. HOT WIRE INITIATORS. The two hot wire initiators (figure 2-4) for the tower jettison motor are threaded plug devices. Both initiators contain the electrical circuitry and explosive necessary to detonate the motor igniters. The initiator body is 1 inch long with a 0.75-inch flange, 0.45 inch from the threaded

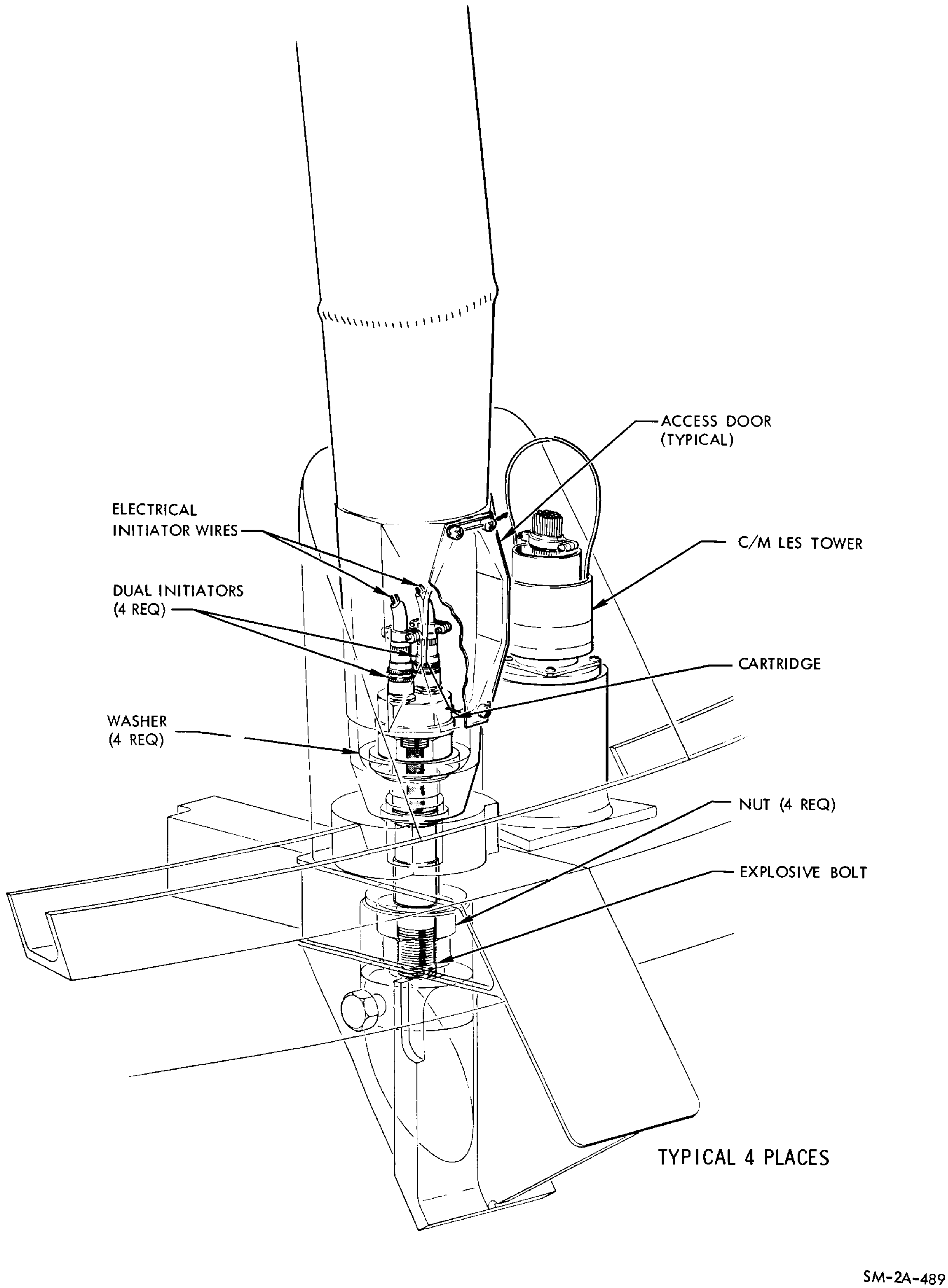

Figure 2-2. Escape Tower Explosive Bolt

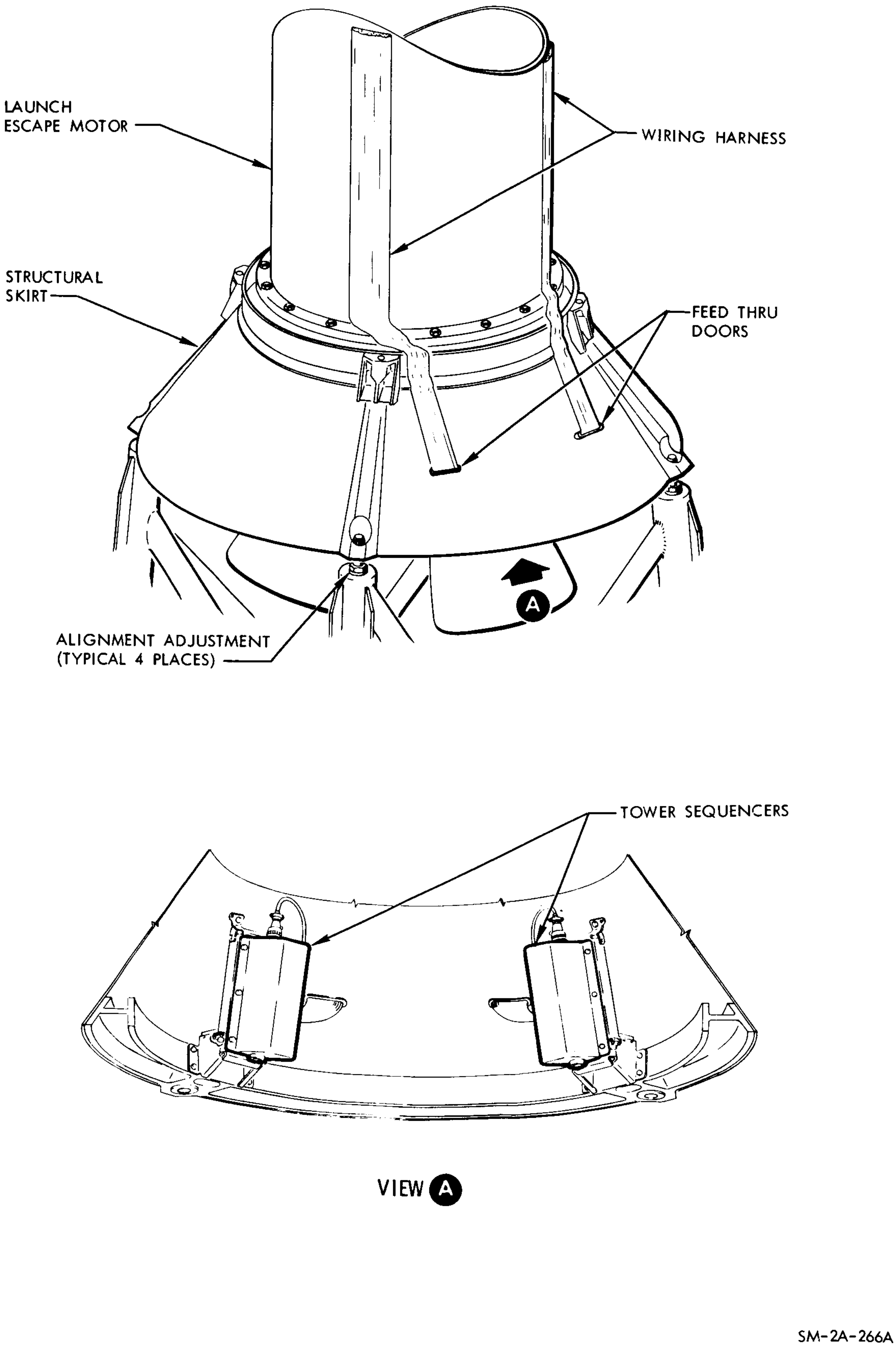

Figure 2-3. Launch Escape Motor and Structural Skirt Area

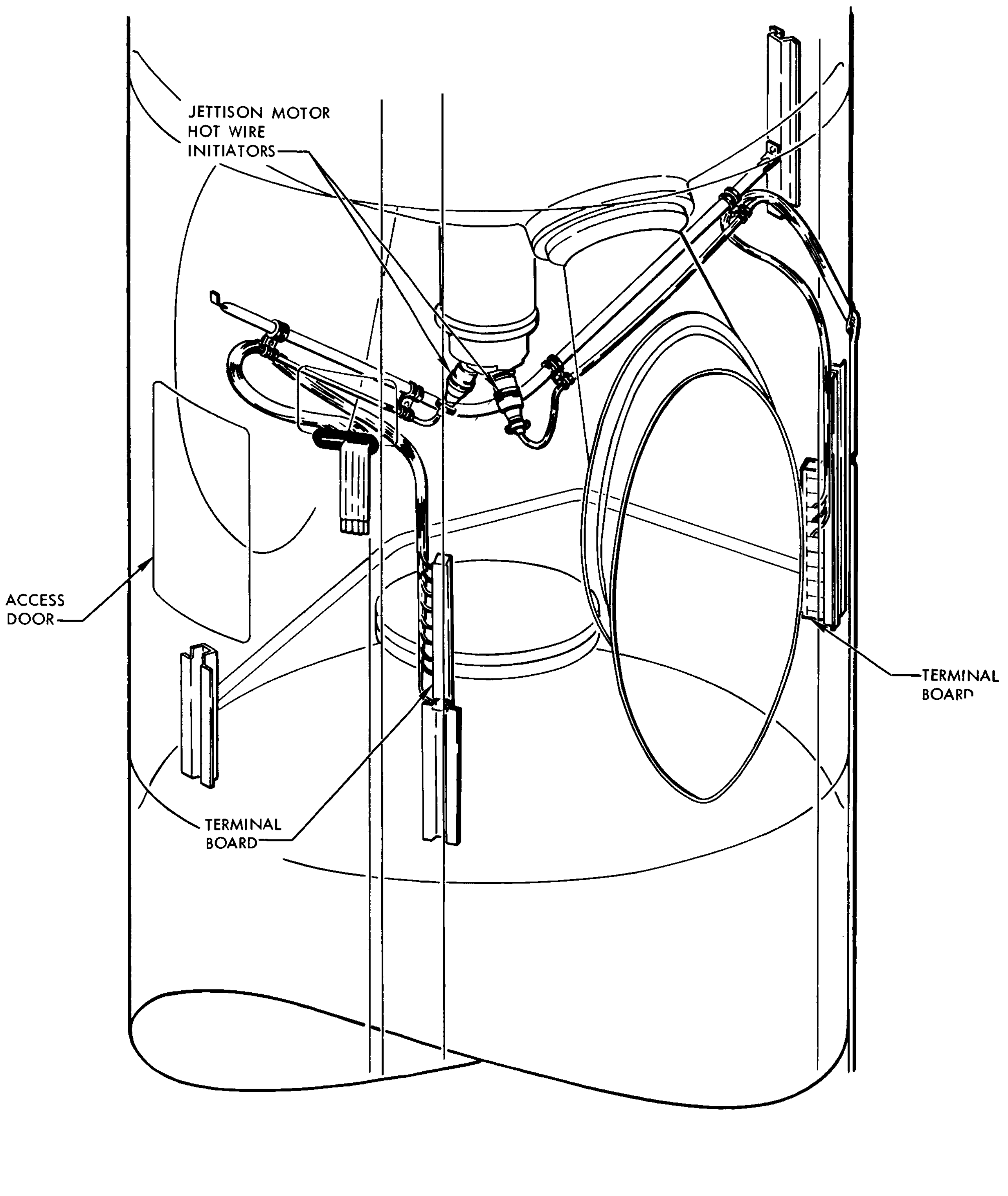

Figure 2-4. LES Interstage Adapter Area Components

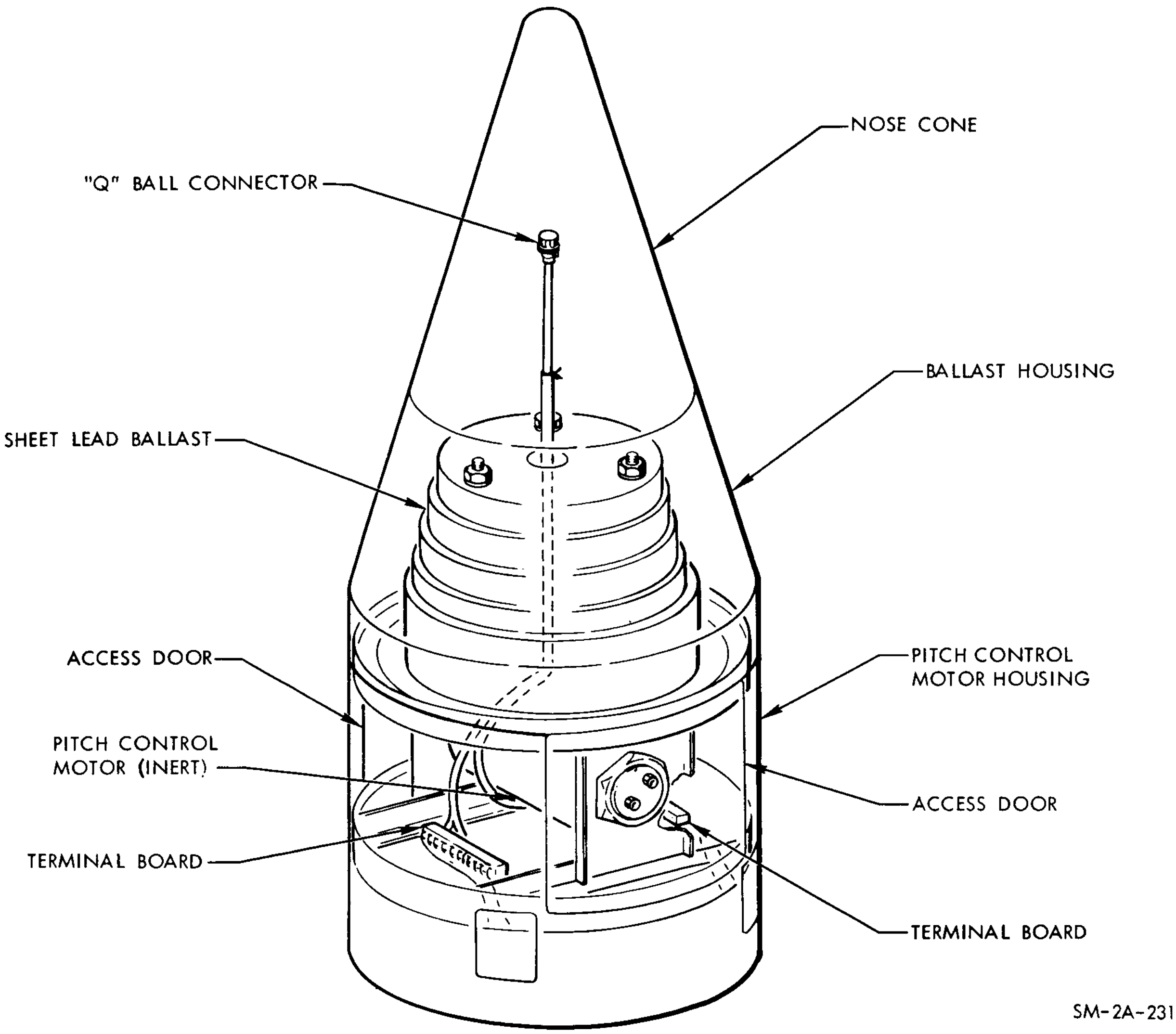

Figure 2-5. Nose Cone and Pitch Control Motor Area

end. Threads are located on one end and an electrical connector at the other end. The electrical connector contains four pins to supply power to two independent bridge-wire circuits.

2-10. LAUNCH ESCAPE TOWER UMBILICAL CONNECTORS. Two electrical umbilical connectors join the electrical systems of the launch escape assembly and the command module. These connectors are located on the plane-of-separation adjacent to the escape tower leg wells of the forward heat shield of the command module. (See figure 2-2.) The receptacle portion of the connector is attached to the command module structure. The plug is attached to the nearest tower leg by a lanyard. When the escape tower separates from the command module, the lanyard pulls the plug from the receptacle. The plugs are part of the launch escape tower wiring installation and separate with the tower. The receptacles are part of the command module wiring installation and remain with the command module.

2-11. COMMAND MODULE. (See figures 2-6 and 2-7.)

2-12. The boilerplate command module simulates the production command module in external size and shape. Physical characteristics for the command module are listed in table 2-2. The reference axes are shown in figure 2-8.

Table 2-2. Command Module Physical Characteristics

Shape	Conical
Height	134 inches
Diameter	154 inches
Weight	9262 pounds (approx)

2-13. STRUCTURE. The command module structure is conical with a convex base and a rounded apex. The sides are semimonocoque aluminum structures and terminate in the forward and aft heat shields. The command module is covered with a cork material to protect the aluminum structure against aerodynamic heating. The crew compartment area is insulated from the side walls with a quilted-fiberglass material. The insulation helps to provide and maintain a constant temperature of not greater than 150 degrees Fahrenheit and to reduce the heat flow inside the compartment. A main hatch in the side of the primary structure permits access to the interior. Shelves and brackets along the inner wall afford mounting provisions for equipment. Compartmentation is described in table 2-3.

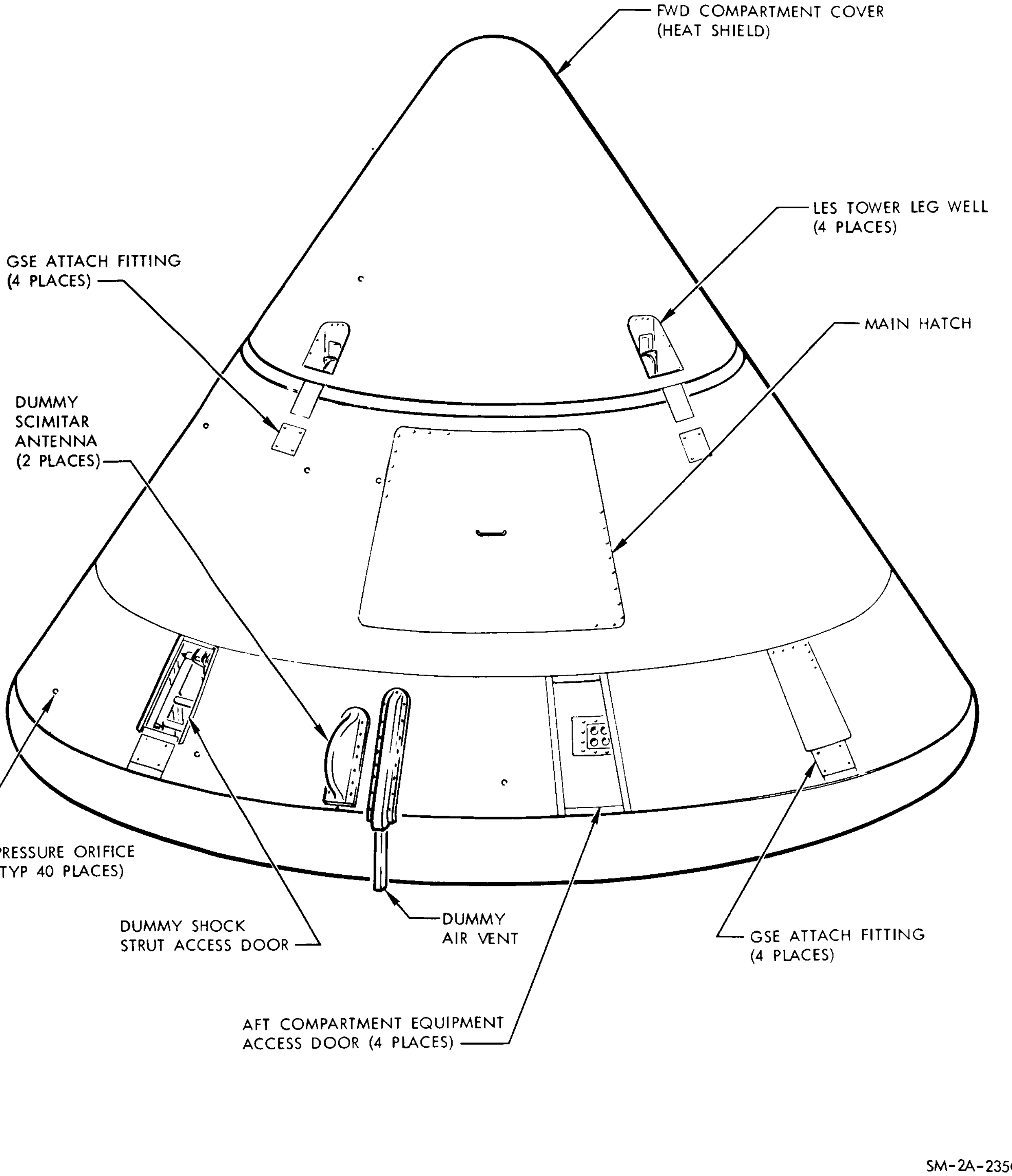

Figure 2-6. Command Module

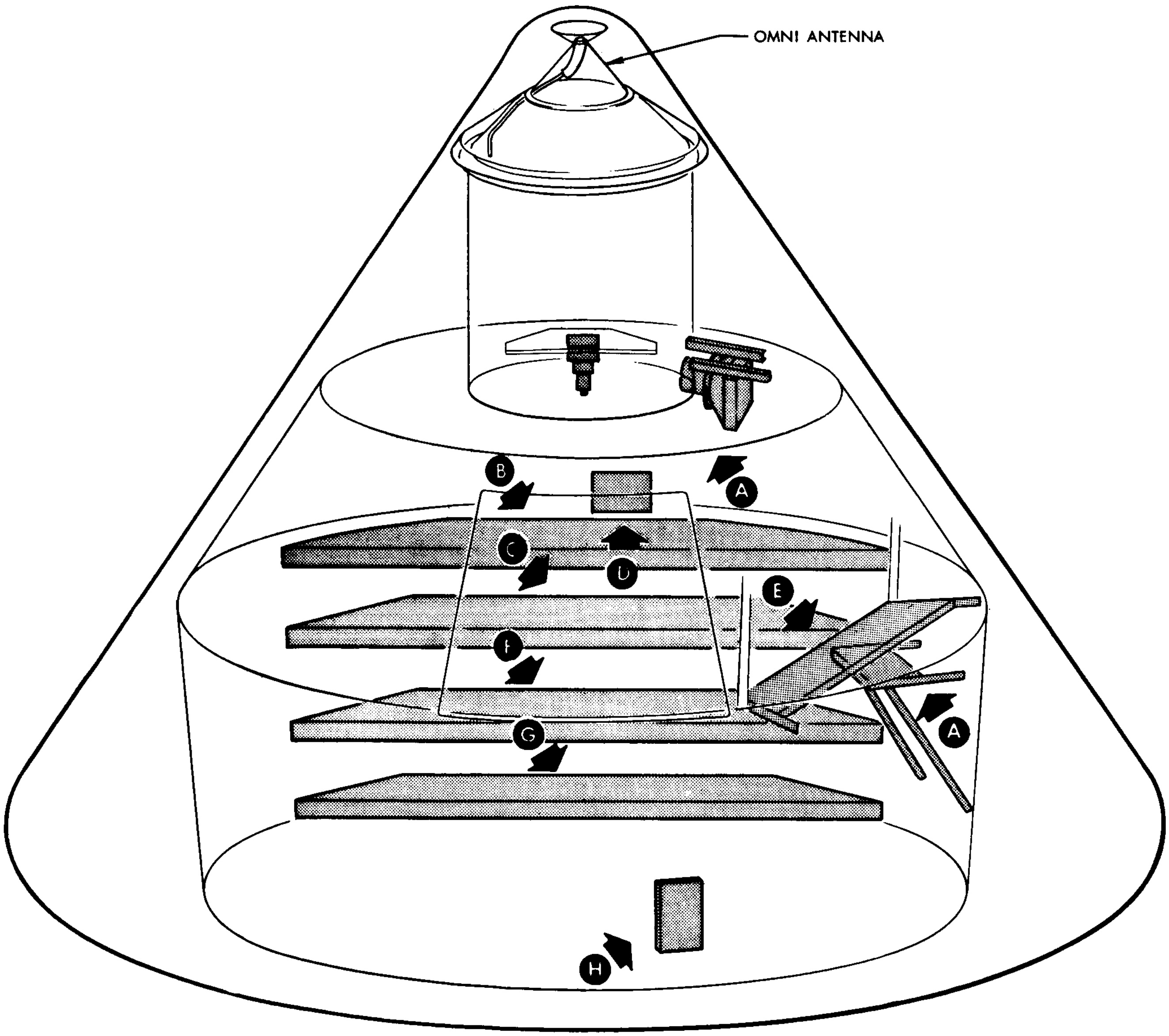

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Figure 2-7. Command Module Interior (Sheet 1 of 5)

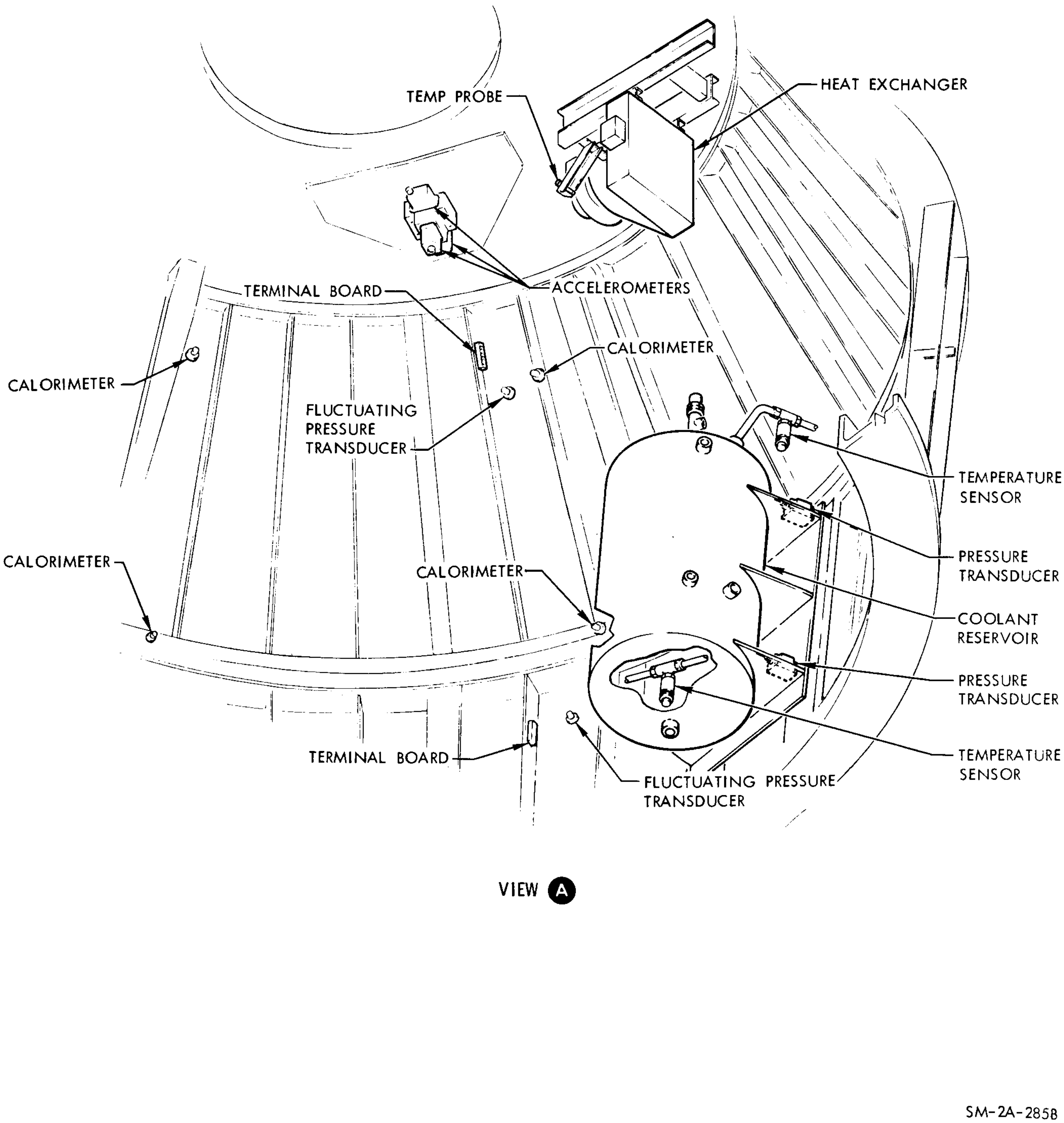


Figure 2-7. Command Module Interior (Sheet 2 of 5)

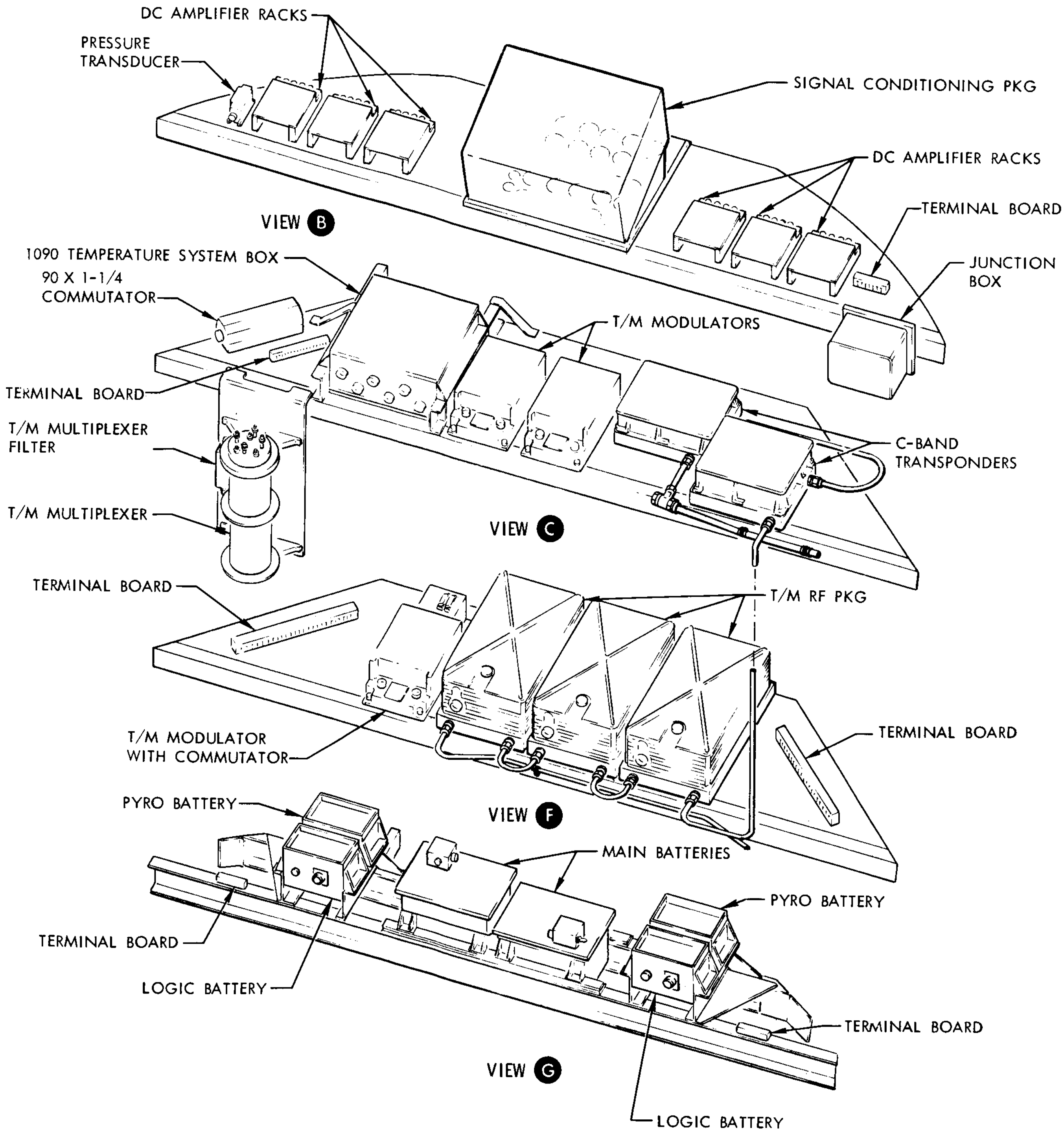


Figure 2-7. Command Module Interior (Sheet 3 of 5)

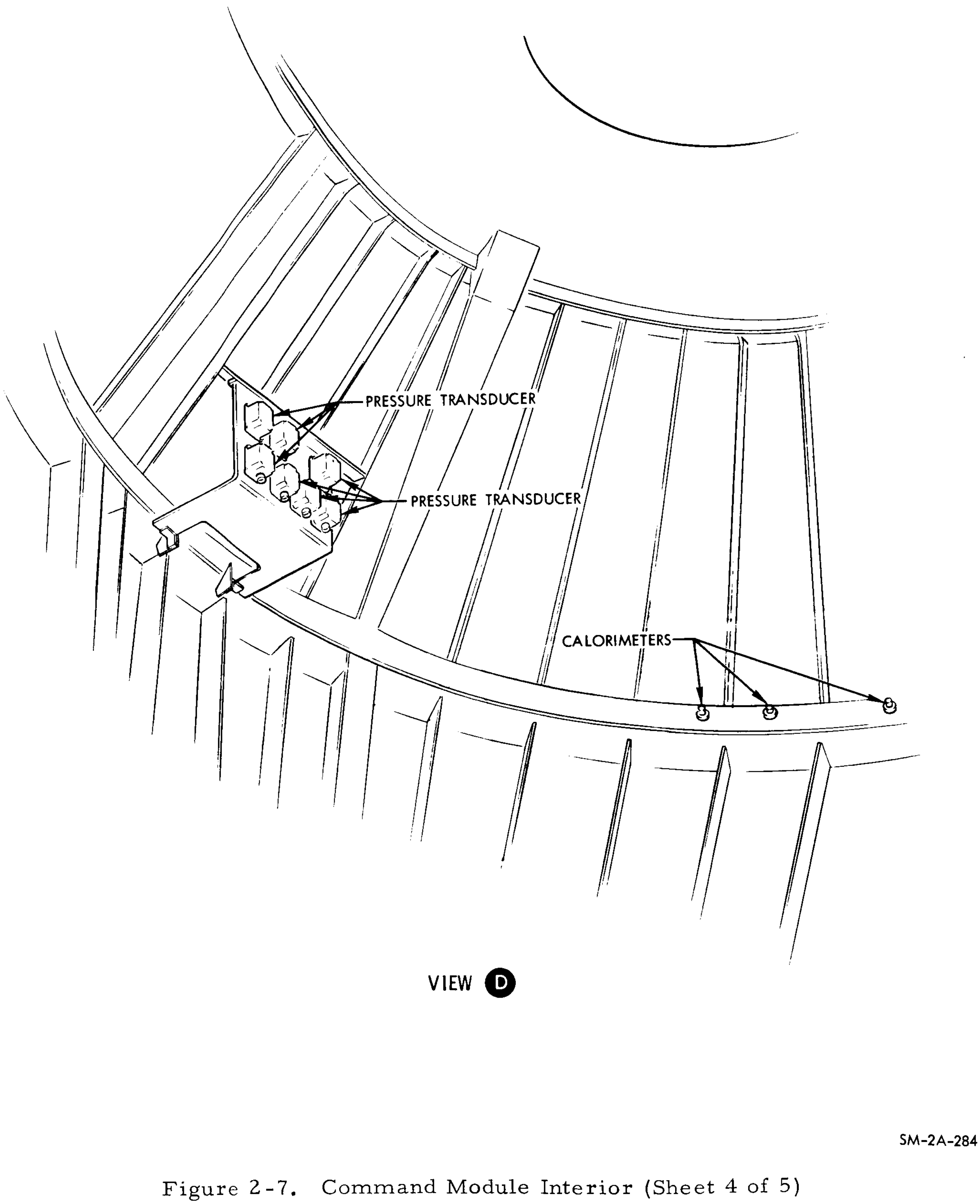


Figure 2-7. Command Module Interior (Sheet 4 of 5)

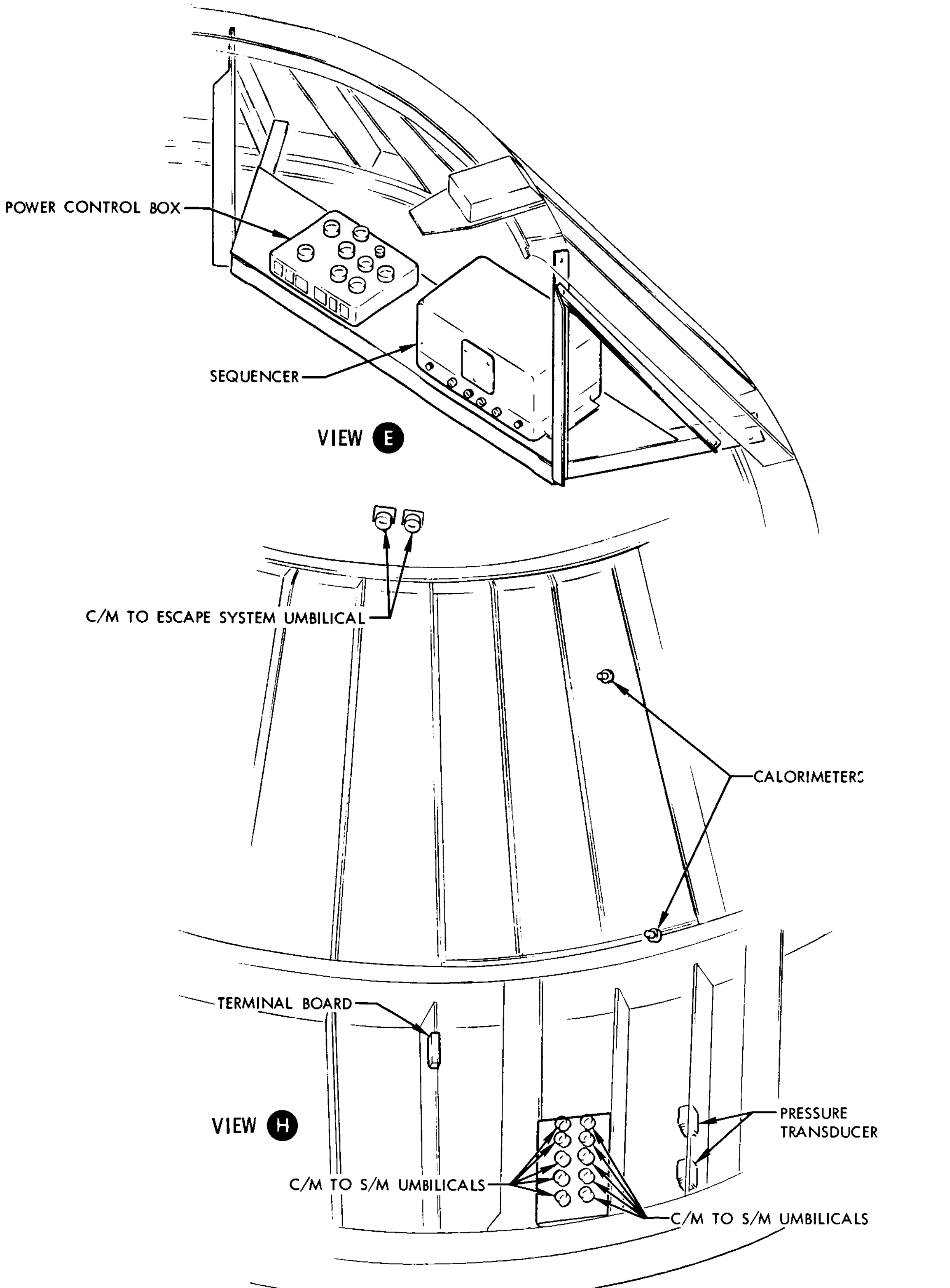


Figure 2-7. Command Module Interior (Sheet 5 of 5)

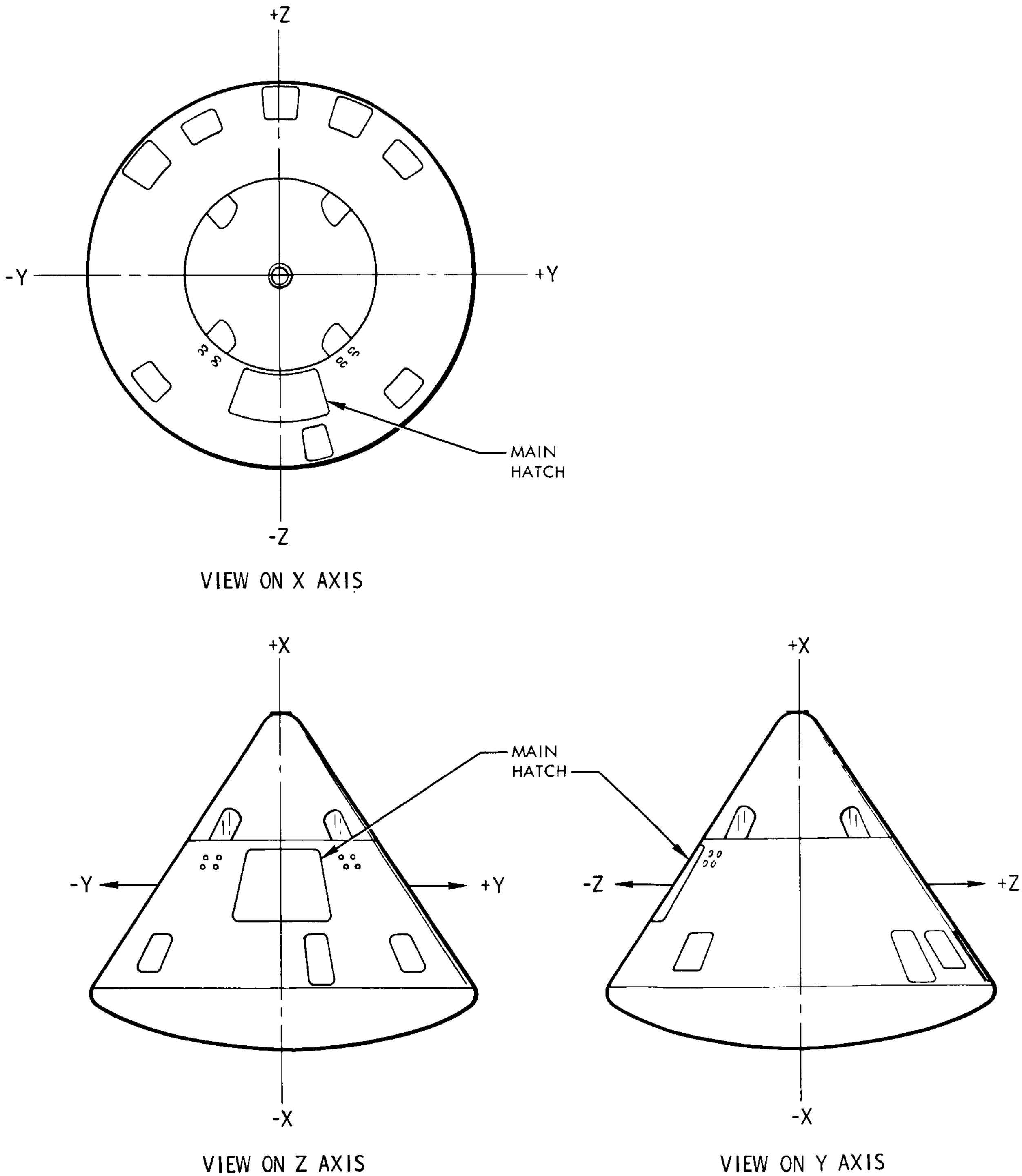


Figure 2-8. Command Module Reference Axis

Table 2-3. Command Module Compartmentation

Compartment	Production Configuration Function	Boilerplate 13 Contents
Primary structure	Crew compartment	Launch escape tower sequencer, R&D communications, and instrumentation. Ballast to simulate weight and center of gravity. Egress tube to simulate production tube volume and main hatch. R&D cooling system.
Forward compartment	Houses parachute system of ELS, reaction thrust jets, and associated equipment	Radome and telemetry antenna.
Aft compartment	Houses impact attenuation struts, environmental control system storage facilities, and C/M to S/M umbilicals	Aft heat shield attachment fittings, GSE attach fittings, umbilical connectors, equipment access doors, service module mating bearing pads, and tension ties.

2-14. FORWARD HEAT SHIELD. The forward heat shield forms the apex of the command module. It consists of a sheetmetal cover and a fiberglass honeycomb radome assembled together, with the assembly bolted to the command module. There are no provisions for separating the forward heat shield, since recovery is not planned.

2-15. AFT HEAT SHIELD. The aft heat shield forms the convex base of the command module. It is constructed of aluminum honeycomb bonded to the inner and outer skins of the laminated fiberglass and is attached to the primary structure of the command module by four adjustable struts. Three of the struts are dummy shock struts (figure 2-9) installed at longerons No. 2, No. 3, and No. 4. The tension tie at No. 1 longeron contains a flange that allows it to be used as a dummy strut and a tension tie. Two holes are provided in the shield for installation of the umbilical electrical connectors. Six holes in the shield allow the command module bearing points to protrude, and three holes permit attachment of the command module to the service module. (See figure 2-11.)

2-16. <u>SERVICE MODULE AND ADAPTER.</u> (See figure 2-10.)

2-17. The service module includes the insert and is used in the boilerplate 13 configuration primarily to transmit loads from the launch vehicle to the spacecraft. The command module rests on the service module at six compression bearing points. Three tension-tie bolts hold the command module mating bearing points

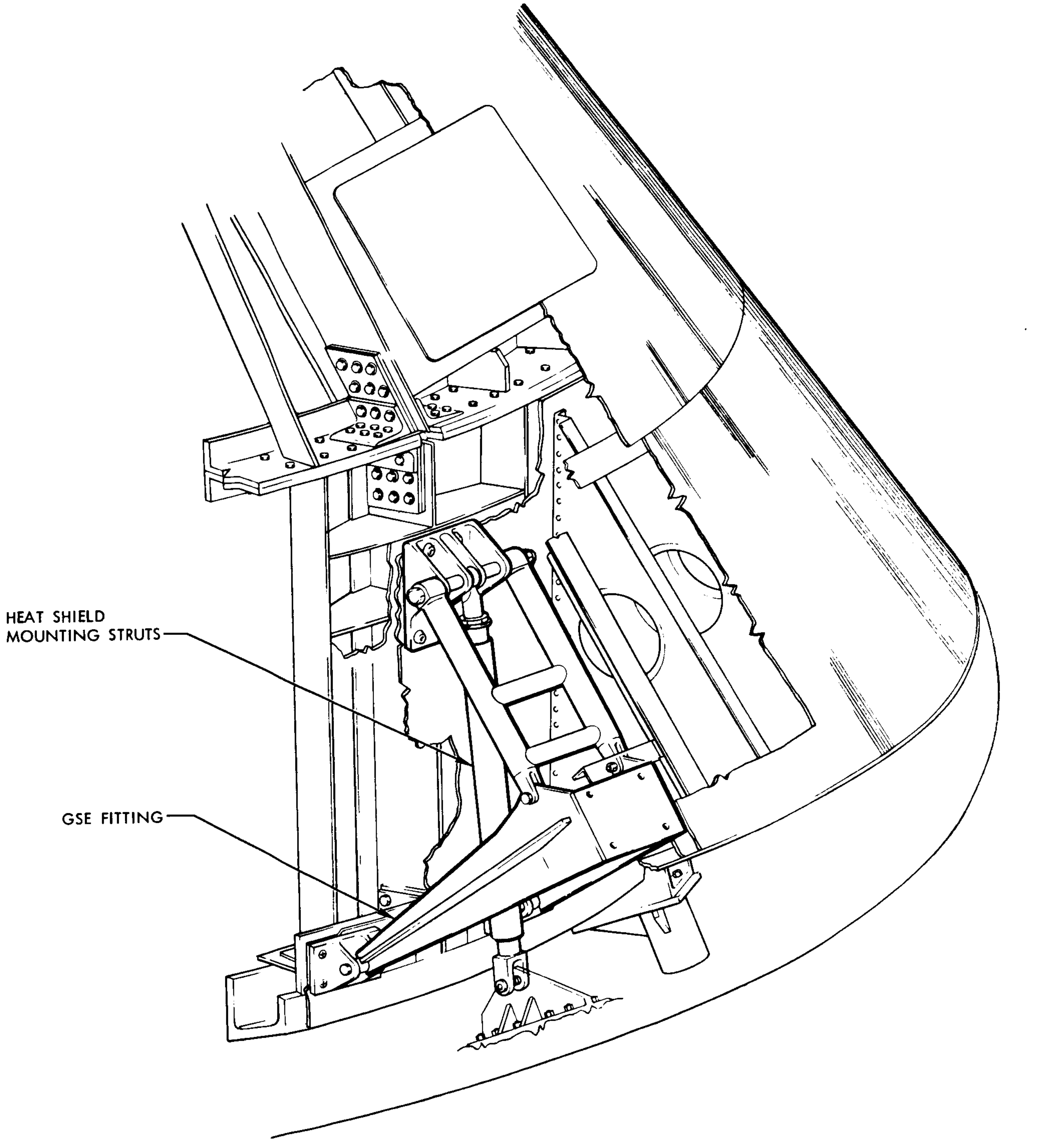


Figure 2-9. Dummy Shock Strut and GSE Attach Fitting

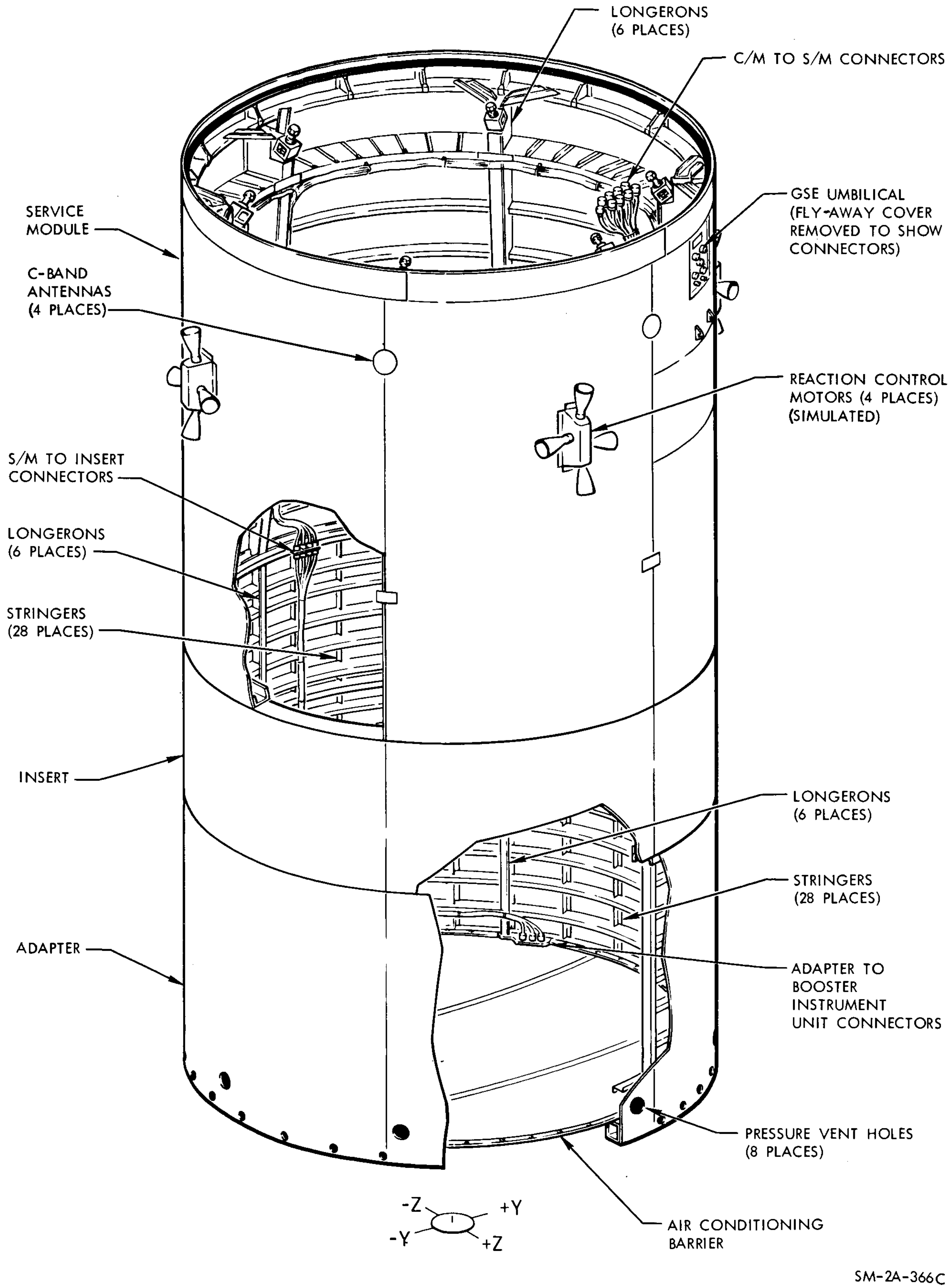


Figure 2-10. Service Module and Adapter

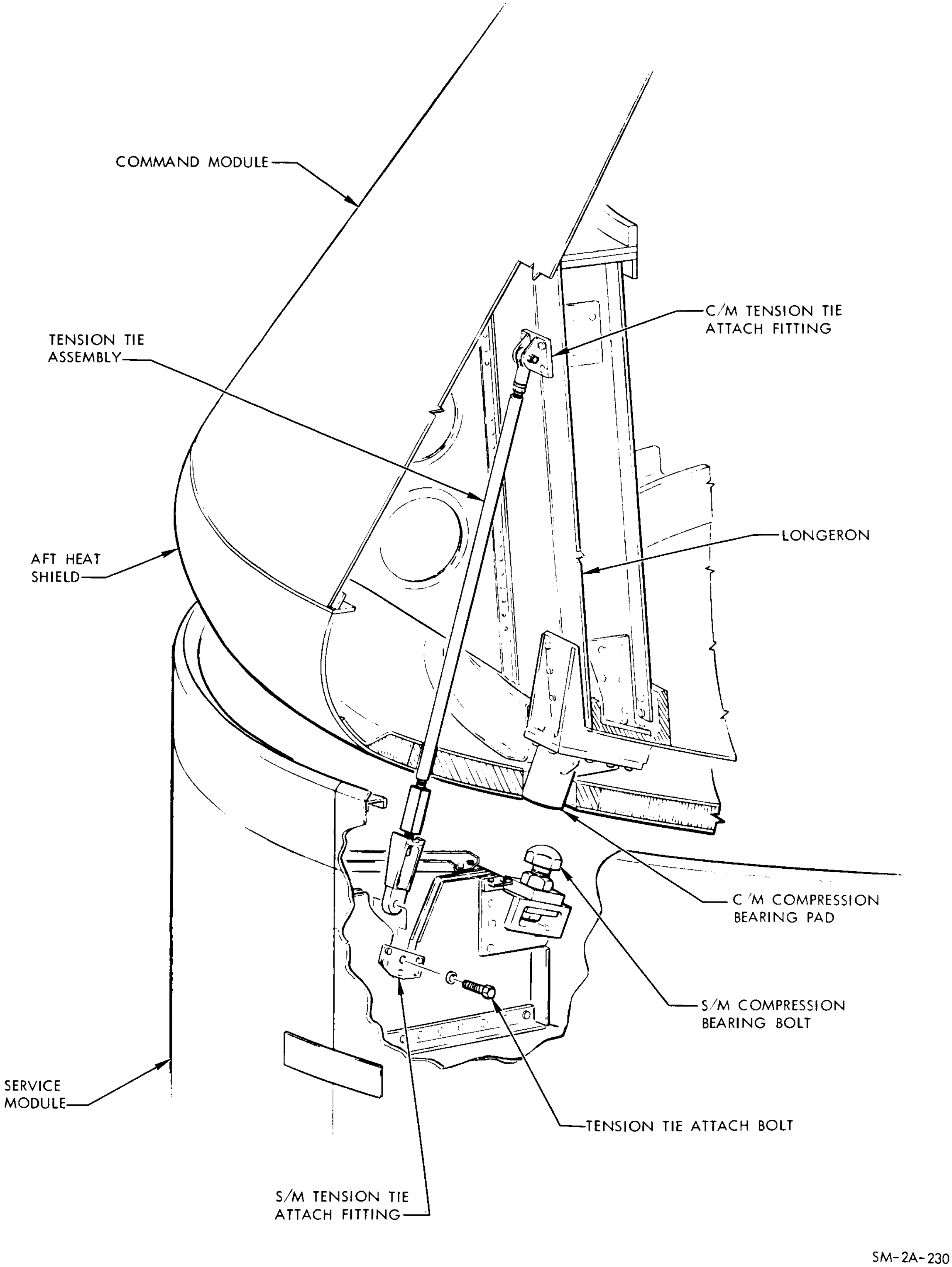


Figure 2-11. Service Module Tension Tie

firmly seated. The six bearing bolts are adjusted to facilitate command module-to-service module alignment. An exterior non-structural fairing is located between the command module and the service module. The fairing houses a non-functioning separation mechanism, a support structure for distributing basic loads imposed by the command module to the service module, and fixed umbilical connections between the two modules. The command module and service module will not be separated during the mission; and, therefore, no pyrotechnics are installed. The service module-to-insert and insert-to-adapter interfaces are joined with 12 bolts each. The adapter is bolted to the instrument unit using 32 bolts. The holes for these 32 bolts are cadmium plated to provide electrical bonding.

2-18. A part of the spacecraft instrumentation system is located in the service module as follows:

a. Service module (between stations 1785.596 and 1661.596, figure 1-1).

   1. Seven calorimeters

   2. Two strain gages

   3. Twelve fluctuating pressure transducers

   4. Three vibration transducers

   5. Two accelerometers

   6. One acoustical-sensing device.

b. Insert (between stations 1661.596 and 1609.596, figure 1-1).

   1. One pressure transducer.

c. Adapter (between stations 1609.596 and 1517.596, figure 1-1).

   1. Four strain gages

   2. One calorimeter

   3. Two vibration transducers.

2-19. Ballast is installed in the service module and adapter to simulate weight and center of gravity of the spacecraft. Fiberglass reaction control system nozzles are mounted in place on the service module to simulate external configuration.

2-20. The adapter contains Apollo-Saturn interface wiring and an air conditioning barrier in addition to the instrumentation (paragraph 2-18). The air conditioning barrier consists of a double layer of nylon cloth impregnated on both sides with a chloroprene rubber compound. The barrier forms a bulkhead at the extreme aft end of the adapter.

2-21. STRUCTURE. The service module, insert, and adapter are cylindrical, of semimonocoque type structure, 154 inches in diameter, with an aluminum outer skin. The service module (less insert) is 124 inches in length. The skin is riveted to aluminum ring frames attached to six longerons. The longerons are T-shaped, the rim part being fabricated of steel and the web of aluminum.

2-22. The insert is 52 inches in length. The skin is riveted to upper and lower ring frames. The upper frame is composed of aluminum angles and webs riveted together; the lower frame is constructed of rectangular aluminum tubing. The upper and lower ring frames are riveted to six steel and aluminum longerons and 28 aluminum stringers.

2-23. The adapter is 92 inches in length. The skin is riveted to longerons and stringers. Eight holes in the aluminum skin, evenly spaced around the aft end of the adapter, provide venting for pressures which may build up in the adapter.

2-24. <u>INTERFACE EQUIPMENT.</u>

2-25. The interface equipment on boilerplate 13 consists of bolts, tension ties, and umbilical connectors. The umbilical connectors consist of electrical connectors and plugs located in the planes of separation of major components, and a GSE umbilical connector for ground support equipment.

2-26. COMMAND MODULE TO SERVICE MODULE TENSION TIE BOLTS. (See figure 2-11.)

2-27. The tension tie bolts utilized to bolt the command module to the service module are steel rod and turnbuckle assemblies. The assemblies are cadmium plated. The turnbuckle is used to preload the command module to the service module compression bearing points. The assemblies are approximately 42 inches long. Two of the assemblies use 7/8-inch hexagon steel rods 28.5 inches long. The third tie at longeron No. 1 uses 1-1/4-inch round steel rod 28.6 inches long on which hexagonal wrench flats have been machined. No pyrotechnic charges are installed on boilerplate 13 configuration. The tension tie at longeron No. 1 also is utilized as a vertical strut to help hold the aft heat shield in place.

2-28. UMBILICAL CONNECTORS.

2-29. The umbilical connectors on boilerplate 13 consist of electrical connectors and plugs located in the planes-of-separation of the modules, a GSE umbilical connector for ground support equipment, and a coolant umbilical connector.

These connectors join the electrical systems of the modules while the modules are attached and provide a means of disconnecting the electrical systems upon module separation. There is no requirement for module separation during boilerplate 13 mission; therefore, the necessary hardware for umbilical disconnect is omitted except for GSE separation. The GSE umbilical supplies the electrical power while the boilerplate is on the pad. The coolant umbilical supplies the fluid coolant from GSE equipment on the pad.

2-30. GSE UMBILICAL CONNECTOR. A GSE umbilical is located in the skin of the service module approximately 18 inches below the top, on the +Z-plane. (See figure 2-8.) This umbilical is equipped with a primary (pneumatic) and a backup (hydraulic) release mechanism. Both systems are armed by a signal from NASA control GSE. Pneumatic and hydraulic pressures are supplied by facility equipment. On initial command, a solenoid actuates the nitrogen pressure which ejects the umbilical. If this system fails to operate, 10 milliseconds later, a hydraulic actuator trips a lanyard which then disconnects the umbilical.

2-31. COMMAND MODULE TO SERVICE MODULE UMBILICAL CONNECTORS. Umbilical connector receptacles are recessed into the outer surface of the aft heat shield of the command module. They are approximately 12 inches from the outer edge and located near longeron No. 6. The receptacles are part of the command module aft compartment wiring installation. The plug portions of the connectors are part of the service module wiring installation.

2-32. SERVICE MODULE TO INSERT UMBILICAL CONNECTOR. Umbilical connector receptacles on the aft separation plane of the service module connect to plugs located in the extension forward end.

2-33. ADAPTER TO INSTRUMENT UNIT UMBILICAL CONNECTOR. Umbilical connector receptacles on the aft separation plane of the adapter connect to plugs located in the forward end of the booster instrument unit. The instrument unit will not be separated from the adapter.

2-34. LAUNCH VEHICLE. (See figure 1-1.)

2-35. The boilerplate 13 launch vehicle is a Saturn I configuration (designated SA-6) consisting of a Saturn S-I booster, a Saturn S-IV second stage, and a booster instrument unit.

2-36. The S-I stage is powered by eight Rocketdyne H-1 engines with a total thrust of 1,500,000 pounds. Propellants for these engines consist of 850,000 pounds of oxidizer LO_2 and fuel RP-1. The general appearance is cylindrical with aerodynamic stabilizing fins at the extreme aft end of the cylinder. The airframe is approximately 21 feet in diameter and is approximately 80 feet in length. First stage engine cutoff is at 150.92 seconds after ignition. An S-I/S-IV interstage section 18 feet in diameter is jettisoned with the first stage.

2-37. The S-IV stage is powered by six Pratt & Whitney RL10-A3 engines with a total thrust of 90,000 pounds. Propellants for these engines consist of 100,000 pounds of oxidizer LO_2 and fuel LH_2. The airframe is approximately 18 feet in diameter with the forward end tapering to 13 feet to interface with the instrument unit and the spacecraft. The S-IV booster burns 464 seconds, placing the booster, instrument unit, and spacecraft into a 90- to 120-mile orbit. No recovery is planned.

2-38. The instrument unit interfaces with the booster and spacecraft. It is approximately 13 feet in diameter and contains the guidance and control system, flight sequencers, telemetry system, tracking system, and electrical power system.

SECTION III

LAUNCH ESCAPE SYSTEM

3-1. PURPOSE.

3-2. The boilerplate 13 launch escape system will demonstrate the structural adequacy of the design by the static and dynamic loads imposed while on the ground, and during lift-off and boost phases.

3-3. OPERATIONAL DESCRIPTION.

3-4. The prototype launch escape system for boilerplate 13 is structurally similar to those used throughout the program; the launch escape motor and pitch control motor are inert. (See figure 2-1.) The escape tower will be jettisoned 10 seconds after S-IV ignition at an altitude of about 266,300 feet. Tower jettison is initiated 12 seconds after S-I/S-IV separation by a booster flight programmer. Figure 3-1 is a functional block diagram showing sequence of events. Table 3-1 is a time history of the events leading to tower jettison.

Table 3-1. Time History of Events Leading to Tower Jettison

Time (Seconds from Ignition)	Event	Velocity (Feet/ Second)	Altitude (Feet)	Dynamic Pressure (Pounds/ Foot^2)	Flight Path Angle (Deg)	Range (KM)	Mach No.
T+0	S-I ignition	0	0	0		0	0
T+3.42	Lift-off				90		
T+72.92	Max Q	1595	41,292	760	53		1.65
T+145.12	S-I inboard Eng. cutoff		197,502	22.4			
T+151.12	S-I burnout	8741	222,409	10.0	24	50	8.98
T+154.12	S-IV ignition	8707	232,043	6.64	24	55	9.22
T+164.12	Escape tower jettison	8800	266,300		21.9	67	

3-5. TOWER JETTISON MOTOR IGNITION.

3-6. The tower jettison motor ignition system contains two electrical hot wire initiators threaded into pyrotechnic cartridges which fire the igniter of the motor. Redundant initiators are employed for increased reliability. Current passing through low resistance wires detonates the cartridge, which in turn ignites the igniter of the rocket motor. The initiator body is 1 inch long with a 3/4-inch

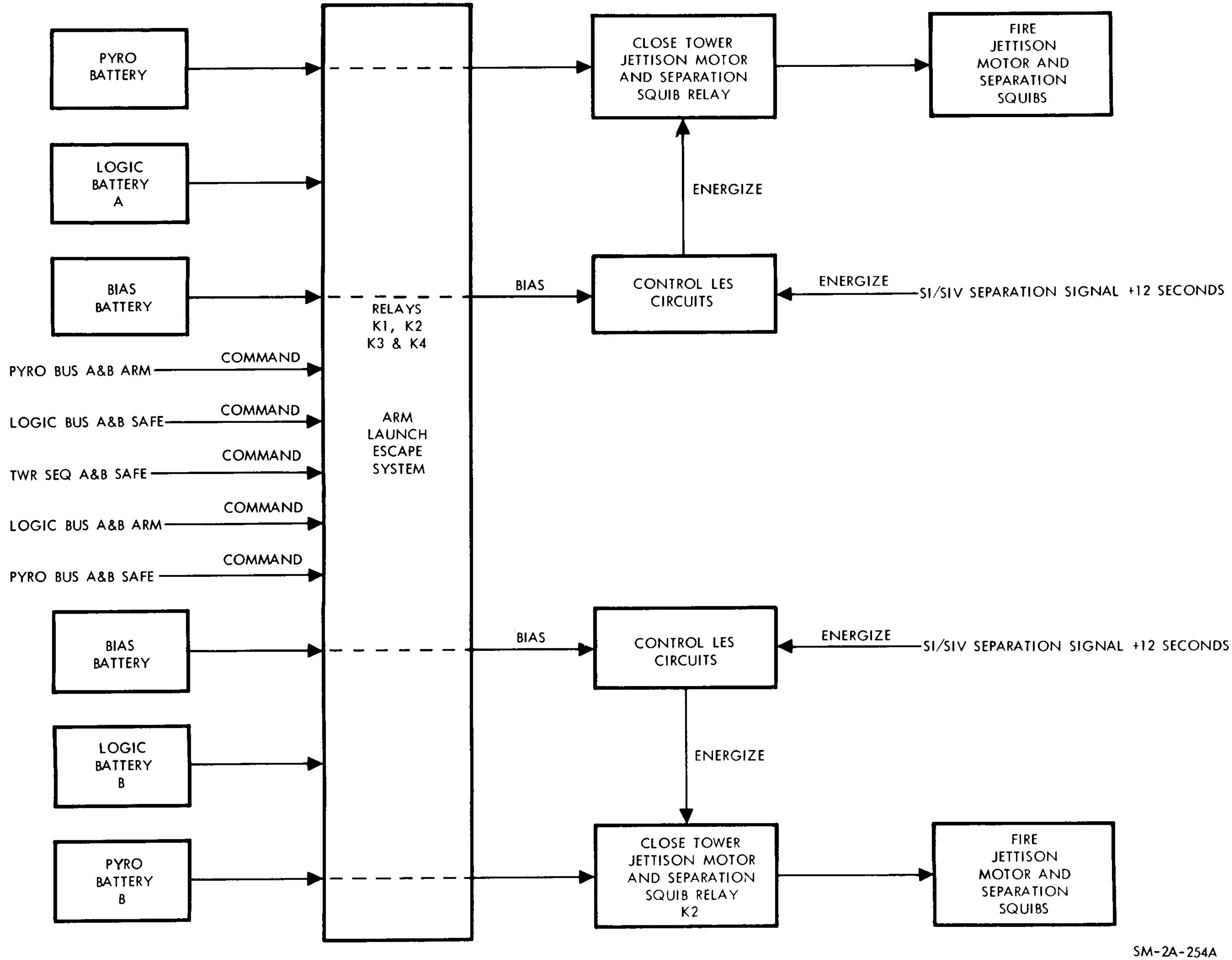


Figure 3-1. Launch Escape System Functional Block Diagram

flange, 0.45 inch from the threaded end. The electrical header contains two independent hot wire circuits and four pins. The initiator ignites within 10 milliseconds when one bridge wire is subjected to a firing current of 3.5 amperes. The pressure level of the explosive charge is produced within 12 milliseconds after application of current. The igniter for the tower jettison motor is installed in the aft dome of the rocket motor. The propellant grain is an 8-point configuration of boron potassium nitrate.

3-7. TOWER SEPARATION.

3-8. The tower separation system consists of four explosive bolts that secure the tower to the command module, (figure 2-2). The explosive bolt charge is contained in the center of the bolt and shatters the bolt when detonated. Release of the tower is accomplished by simultaneous detonation of the four explosive bolts. The hot wire initiators for the bolts are ignited by 28-volt d-c signals recieved from the mission sequencer through the tower sequencers. The initiators will detonate to fire the explosive bolts within 5 milliseconds. To accomplish tower jettison, the mission sequencer simultaneously initiates detonating signals to the explosive bolts and to the tower jettison motor hot wire initiators. The entire launch escape assembly is released and pulled clear of the spacecraft trajectory. The tower to command module umbilical connections are disconnected automatically when tower separates from the command module.

3-9. LAUNCH ESCAPE MOTOR.

3-10. Boilerplate 13 uses an inert launch escape motor which contains ballast to simulate the weight of a live launch escape rocket motor. The motor will weigh approximately 4800 pounds with ballast installed. (See figure 2-1.)

3-11. PITCH CONTROL MOTOR.

3-12. Boilerplate 13 uses an inert pitch control motor which contains ballast to simulate the weight of a live pitch control motor. The motor weighs approximately 47 pounds with ballast installed. (See figure 2-1.)

3-13. LAUNCH ESCAPE TOWER JETTISON MOTOR.

3-14. The tower jettison motor is a solid-propellant motor that provides the thrust for separation of the launch escape tower and related equipment from the command module. The jettison motor is mounted on top of the inert escape motor. Passive thrust vector control in the form of offset exhaust nozzles provide a trajectory that arcs slightly in the pitch-up direction. For operational characteristics of the jettison motor, refer to table 3-2.

Table 3-2. Operational Characteristics of Launch Escape Tower Jettison Motor

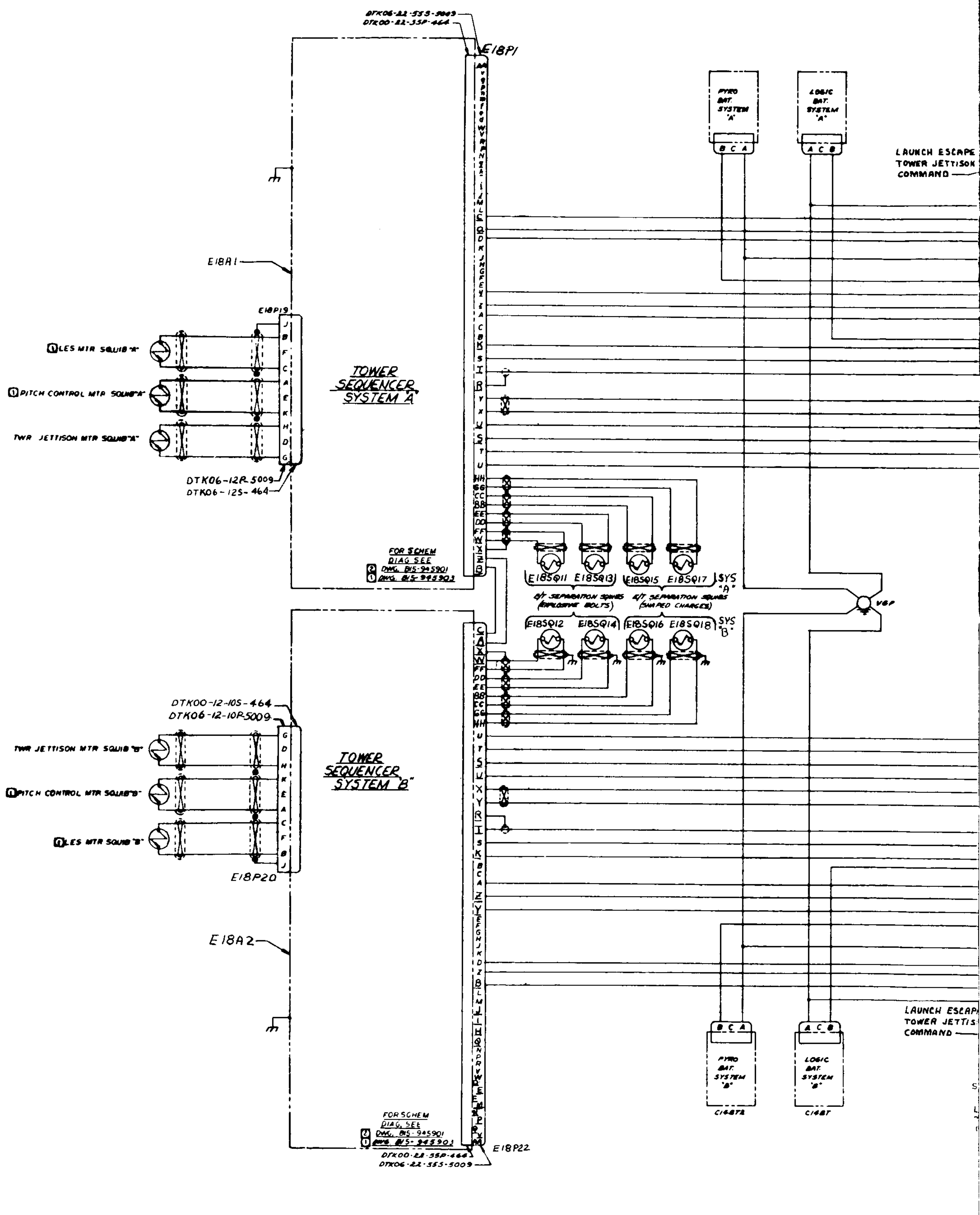
Thrust	31,600 pounds
Duration	1.07 second
Time required to reach 90-percent maximum thrust	75 to 125 milliseconds
Angles between resultant thrust axis and motor:	
Pitch plane	2 degrees 30 minutes ±30 minutes
Yaw plane	0 degrees ±30 minutes

3-15. MISSION SEQUENCER. (See figures 2-7 and 3-2.)

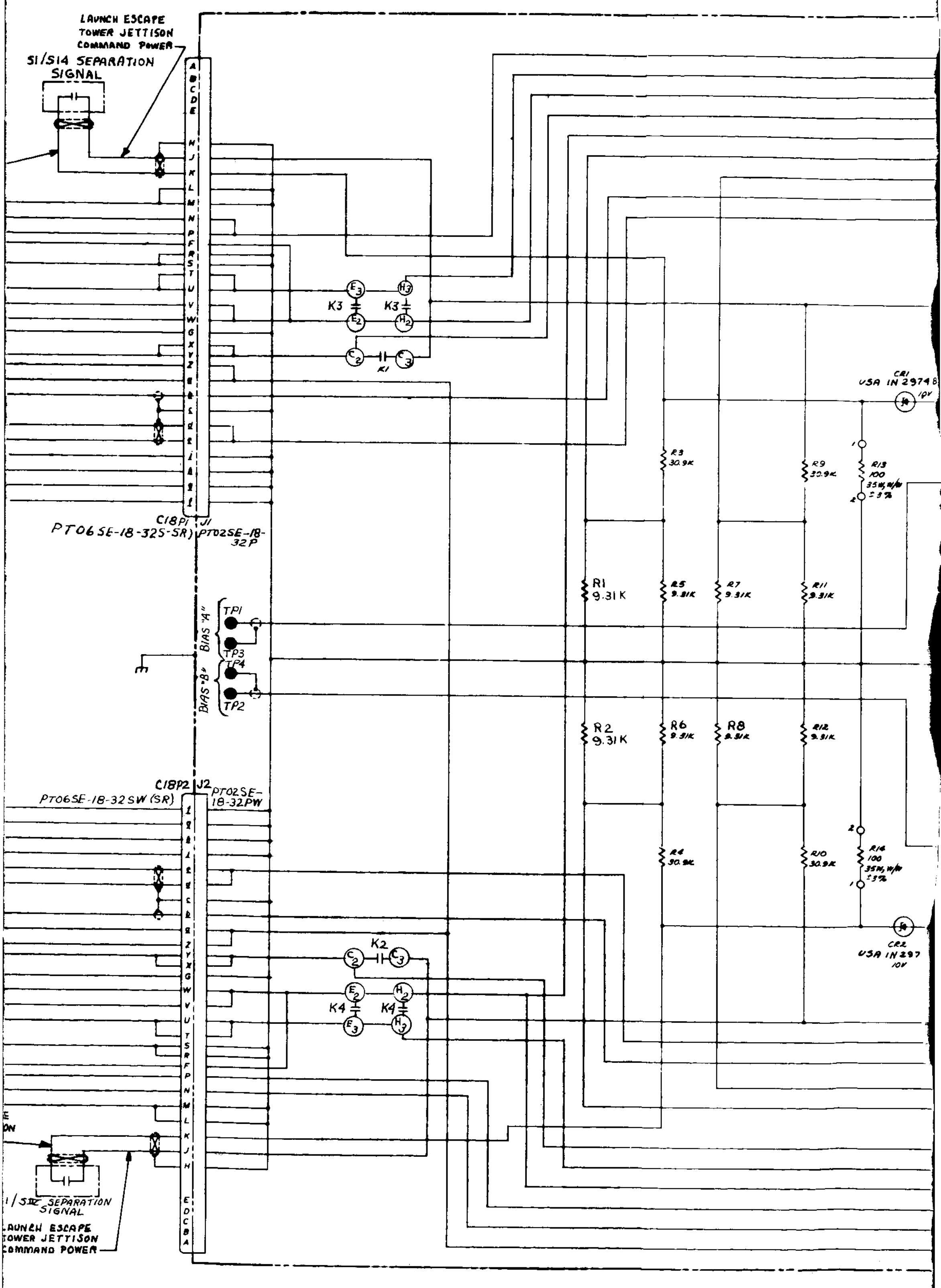
3-16. The mission sequencer located in the command module controls the sequence of events that are necessary to execute a successful launch escape tower jettison operation. The sequencer contains the logic circuits to direct the timing and order of the electrically initiated steps of the mission. Complete redundance of the entire sequential network is provided for added reliability. The mission sequencer logic circuits send the electrical signals to operate the motor switches in the tower sequencer. The switches then allow electrical power from the pyro bus to simultaneously fire the explosive bolt squibs and ignite the tower jettison motor. Table 3-3 gives mission sequencer functions. In addition, the mission sequencer provides compatibility of monitoring critical events as they occur, thus providing an input to the instrumentation system.

3-17. TOWER SEQUENCERS. (See figures 2-3 and 3-3.)

3-18. Two tower sequencers are attached to the underside of the structural skirt. Each sequencer has one motor-driven switch. An output voltage from the mission sequencer drives each motor-driven switch to the ARM position. The switches then allow electrical power from the pyro bus to simultaneously fire the tower separation explosive bolts and ignite the jettison motor. The sequencer provides circuits for monitoring the functional status of the control circuits via GSE during checkout operations. Use of two sequencers provides total redundancy for added reliability.

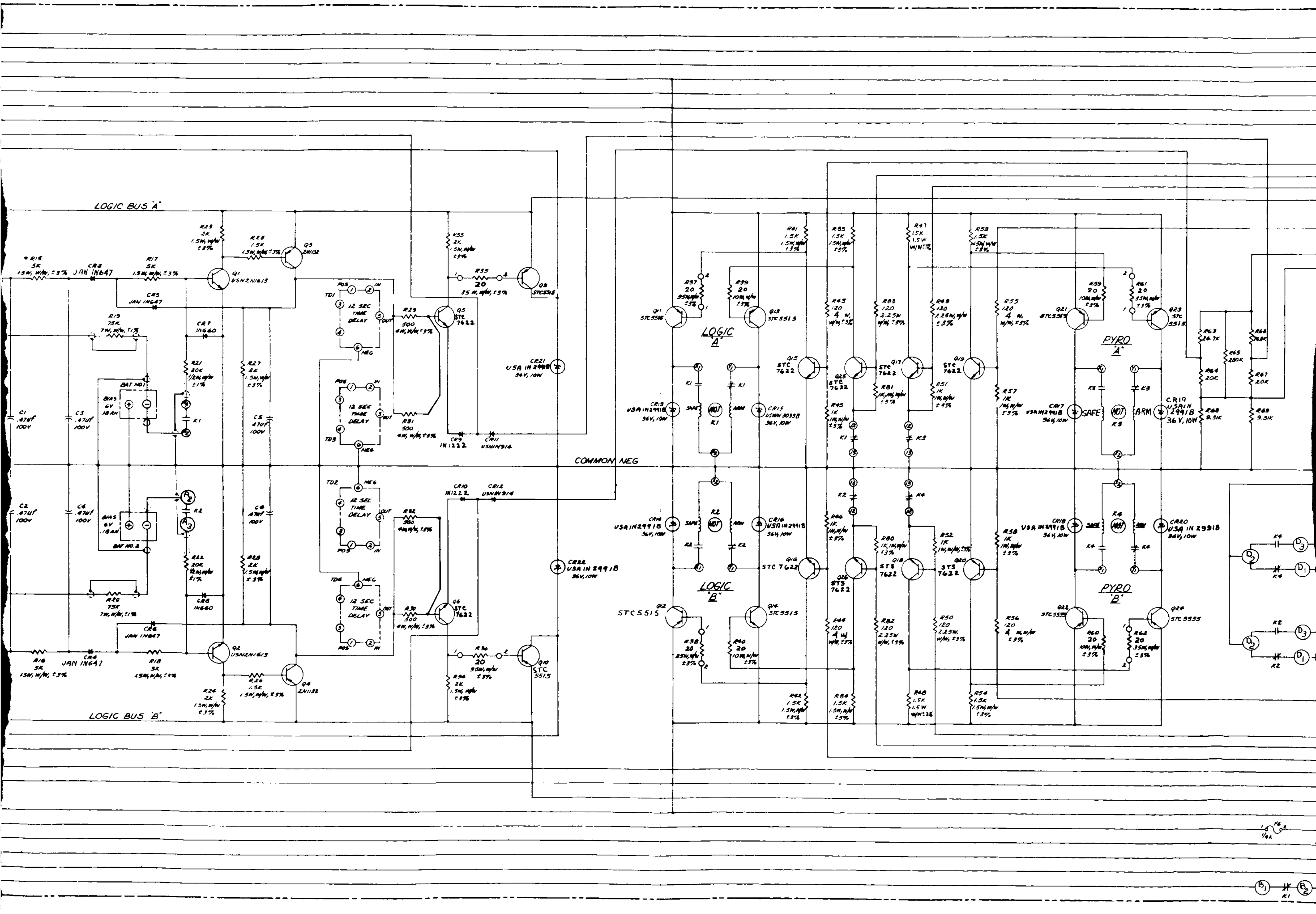


DTK06-22-55S-5009
DTK00-22-55P-464
E18P1
PYRO BAT. SYSTEM "A"
LOGIC BAT. SYSTEM "A"
LAUNCH ESCAPE TOWER JETTISON COMMAND
E18A1
E18P19
LES MTR SQUIB "A"
PITCH CONTROL MTR SQUIB "A"
TWR JETTISON MTR SQUIB "A"
TOWER SEQUENCER SYSTEM "A"
DTK06-12P-5009
DTK06-12S-464
FOR SCHEM DIAG SEE DWG. BIS-945901 DWG. BIS-945903
E18SQ11 E18SQ13 E18SQ15 E18SQ17 SYS "A"
E18SQ12 E18SQ14 E18SQ16 E18SQ18 SYS "B"
DTK00-12-10S-464
DTK06-12-10P-5009
TWR JETTISON MTR SQUIB "B"
PITCH CONTROL MTR SQUIB "B"
LES MTR SQUIB "B"
TOWER SEQUENCER SYSTEM "B"
E18P20
E18A2
LAUNCH ESCAPE TOWER JETTISON COMMAND
PYRO BAT. SYSTEM "B"
LOGIC BAT. SYSTEM "B"
DTK00-22-55P-464
DTK06-22-55S-5009
E18P22



LAUNCH ESCAPE TOWER JETTISON COMMAND POWER
S1/S14 SEPARATION SIGNAL
C18P1
PT06SE-18-32S-SR)
J1
PT02SE-18-32P
K3
K1
K2
K4
BIAS "A"
BIAS "B"
TP1
TP2
TP3
TP4
R1 9.31K
R2 9.31K
R3 30.9K
R4 30.9K
R5 9.31K
R6 9.31K
R7 9.31K
R8 9.31K
R9 30.9K
R10 30.9K
R11 9.31K
R12 9.31K
R13 100
R14 100
CR1 USA 1N2974B 10V
CR2
C18P2
J2
PT06SE-18-32SW (SR)
PT02SE-18-32PW
SEPARATION SIGNAL
LAUNCH ESCAPE TOWER JETTISON COMMAND POWER

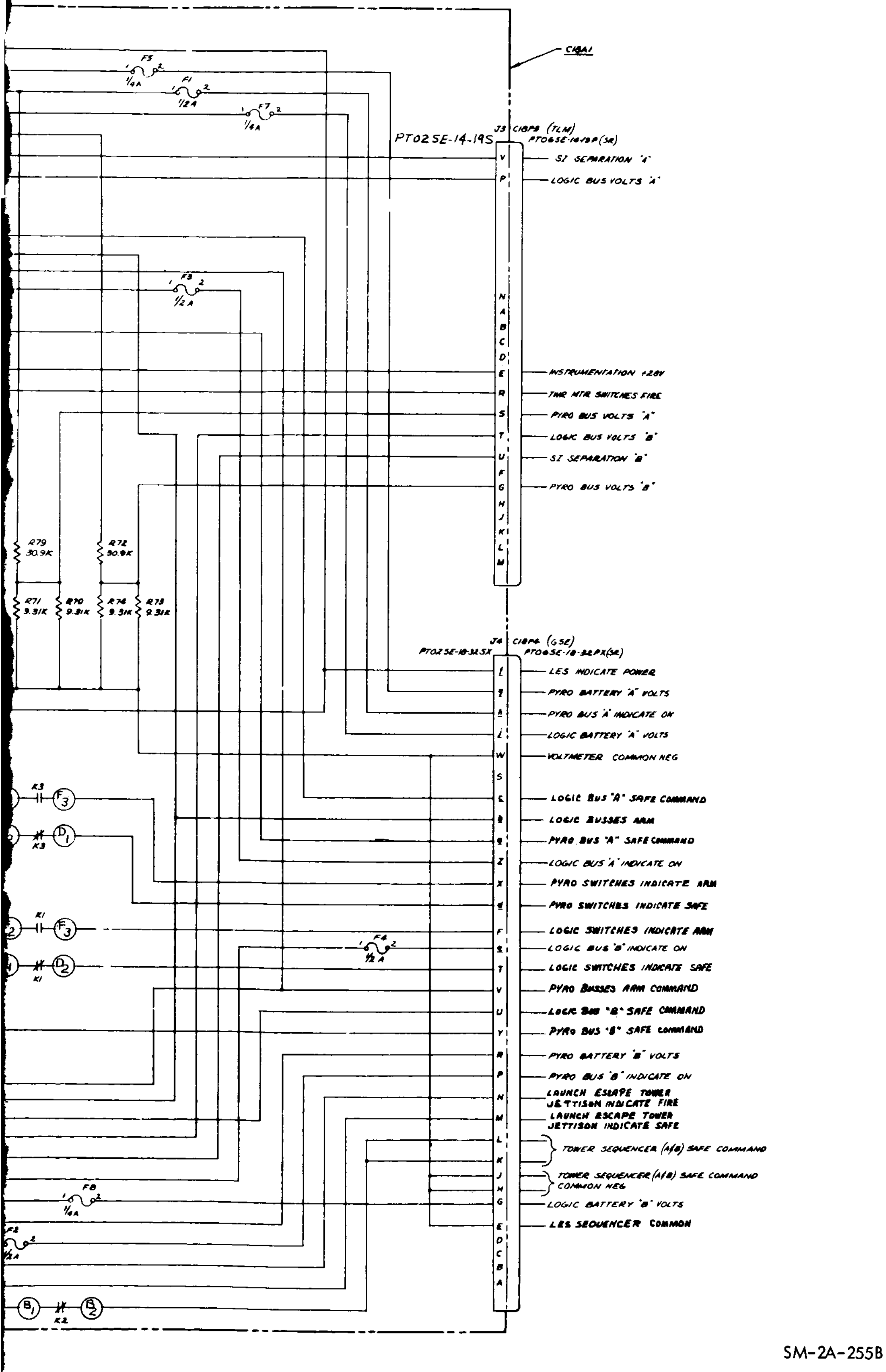
2



LOGIC BUS "A"
LOGIC BUS "B"
COMMON NEG
LOGIC "A"
LOGIC "B"
PYRO "A"
PYRO "B"
12 SEC TIME DELAY
BAT NO.1
BAT NO.2
SAFE
ARM

3

F



gure 3-2. Mission Sequencer Schematic Diagram

4

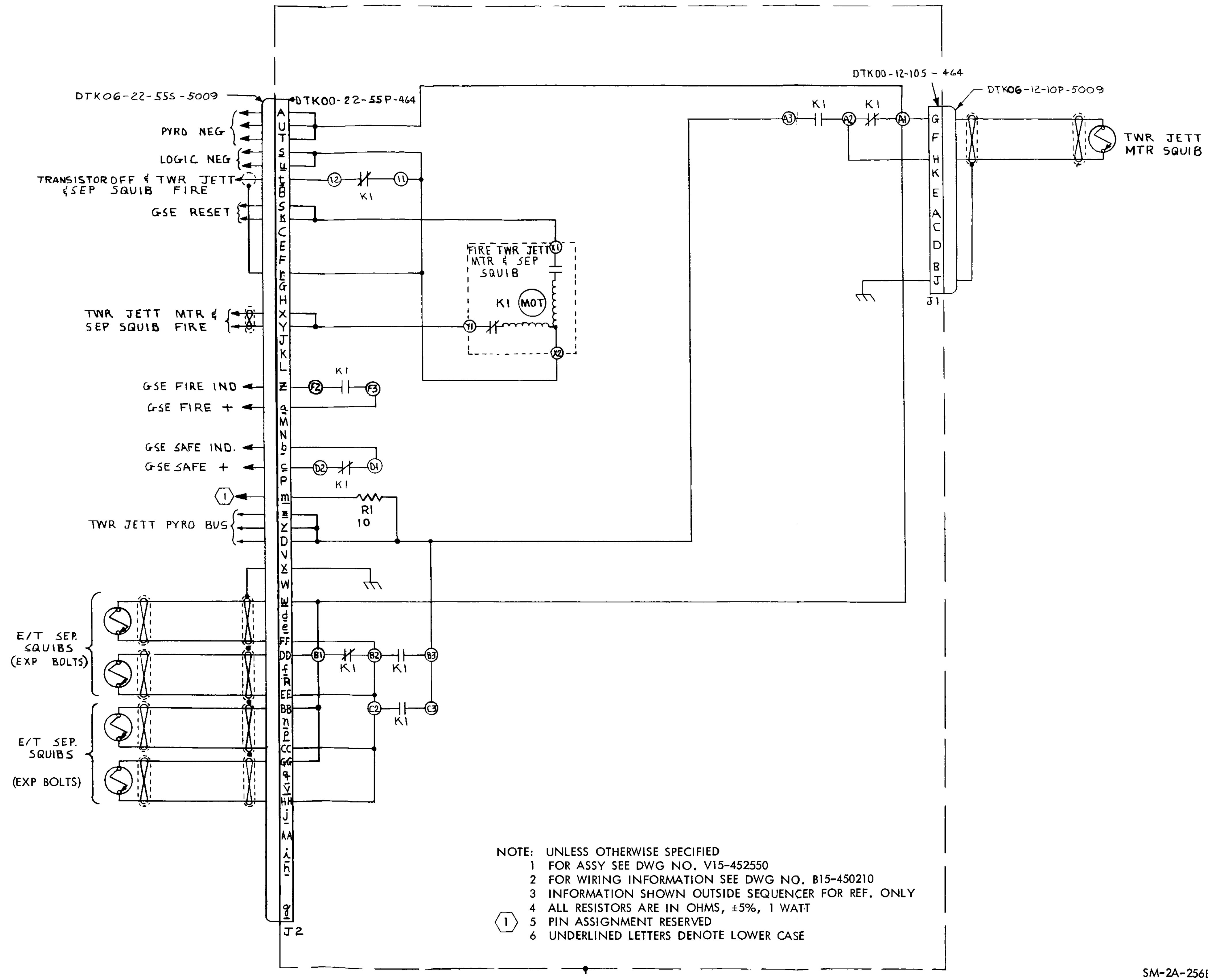


Figure 3-3. Tower Sequencer Schematic Diagram

Table 3-3. Mission Sequencer Functions

Signal	Function	Time	Controlling Components	Signal Source
Logic bus A & B arm command	Supplies base voltage for transistorized switching network to energize coils of motor-driven switches C18K1 and C18K2.	Prelaunch	C18J4-b	GSE
Logic bus A & B	Supplies collector voltage to transistorized switching network to energize coils of motor-driven switches E18K1 and E18K2 and for arming of S-I separation signal.	Prelaunch	C18K1 and C18K2, C18J4-X, C18J4-Y, C18J2-X, and C18J2-Y	Logic batteries A and B
Pyro bus A & B arm command	Supplies base voltage for transistorized switching network to energize coils of motor-driven switches C18K3 and C18K4.	Prelaunch	C18J4-V	GSE
Pyro bus A & B	Supplies voltage to firing contacts of E18K1 and E18K2.	Prelaunch	C18K3 and C18K4, C18J1-T, C18J1-U, C18J2-T, and C18J2-U	Pyro batteries A
S-I separation	Supplies base voltage to transistorized switching network to energize coils of motor-driven switches E18K1 and E18K2.	S-I separation plus 12 seconds	IU programmer C18J1-J, C18J1-K, C18J2-J, and C18J2-K	Logic bus A and B
Launch escape tower jettison	Supplies firing voltage to tower jettison motor and launch escape tower separation squib initiators.	S-I separation plus 12 seconds	E18K1 and E18K2	Pyro bus A and B

SECTION IV

COMMUNICATIONS AND INSTRUMENTATION

4-1. PURPOSE.

4-2. The communications and instrumentation system provides a means of acquiring and conditioning preselected information and of transmitting this information to earth monitoring equipment. (Refer to table 4-1 for measurement list.) The system also provides for tracking of the spacecraft during the mission. The Q-ball contains some instrumentation equipment, the information being used for guidance. The Q-ball system is not connected functionally with the Apollo communications and instrumentation system, but is described in this section.

4-3. DESCRIPTION. (See figure 4-1.)

NOTE

For detailed descriptive and checkout information for the R&D electronic equipment furnished by NASA, refer to applicable NASA manuals.

4-4. COMMUNICATIONS EQUIPMENT.

4-5. Communications R&D equipment consists of the telemetry system and radar transponders.

4-6. TELEMETRY SYSTEM. The telemetry system consists of three FM/FM telemetry subsystems; one subsystem containing two PAM channels, the transmitters of each operating into the antenna system. In addition to the transmitter, each telemetry subsystem includes subcarrier oscillators. Subsystem A contains a 90 by 10 and a 90 by 1-1/4 commutator. The 90 by 1-1/4 commutator is used for temperature measurements.

4-7. Transmitting frequencies of the three systems are as follows:

Telemetry system A	237.8 mc
Telemetry system B	247.3 mc
Telemetry system C	257.3 mc

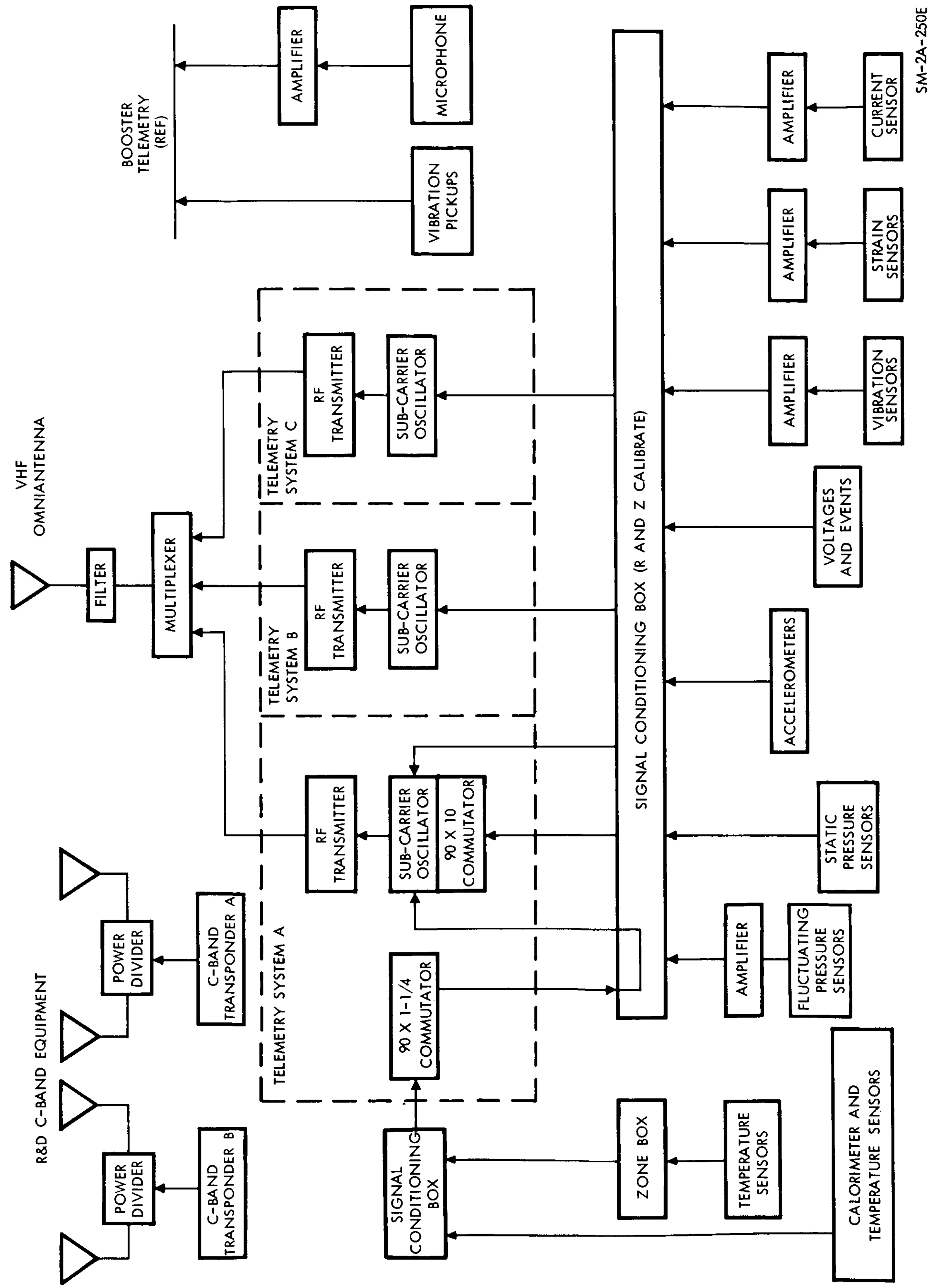


Figure 4-1. R&D Instrumentation Block Diagram

4-8. The antenna system consists of a multiplexer, a filter, and vhf omni-antenna. The antenna is located under a radome in the nose of the command module.

4-9. RADAR TRANSPONDERS. The two radar transponders operate in the C-band, receiving at 5690 mc and transmitting at 5765 mc. The transponders are interrogated by a 2-pulse code spaced at intervals of 3.5 microseconds between leading edges and followed by a 2.0 microsecond delay. The repetition rate will be consistent with range tracking requirements.

4-10. The radar transponder antenna system includes two power dividers and four cavity-helical, flush-mounted antennas. The antennas are mounted 90 degrees apart around the upper section of the service module.

4-11. INSTRUMENTATION EQUIPMENT.

4-12. Instrumentation equipment includes the necessary transducers, sensors, and other devices to monitor physical and thermal effects of flight upon the spacecraft and to convert them into electrical signals suitable for telemetering. The devices are located in and on the spacecraft as shown in figure 4-2. Table 4-1 consists of identification number, measurement description, channel, data range, priority, response, and location of these devices. Subheadings in the Channel columns indicate the following: LK (link) designates the telemetry (r-f carrier) package A, B, or C,; SC No. (subcarrier number) designates telemetry channels 1 through 18, and Com Seg (commutator segment) designates the telemetry commutator segment assigned to the measurement for that vehicle. LV TM (launch vehicle telemetry), which appears in the Channel LK and SC No. columns, designates a measurement to be telemetered by launch vehicle telemetry. The Data Range columns denote minimum and maximum values for a parameter in engineering units. The following letters in the PR (priority) column indicate how critical the measurement: P (primary) denotes measurements that must be available at launch for mission success and to meet the flight objectives; S (secondary) denotes measurements that are highly desirable, but will not abort or delay the mission if inoperative, and M (multiple) designates a group of measurements of which only a specified percentage may be inoperative. The Response column denotes the rate and unit required to provide satisfactory data resolution to time or waveform. Response for continuous data monitoring (telemetry or recorder) is specified in cycles per second (cps), and sampled-data monitoring (PCM or PACE) is specified in samples per second (S/S). The location column refers to the coordinates which denote the physical location within the spacecraft where the measurement is taken.

4-13. SIGNAL CONDITIONING. The signal conditioning equipment adapts all signals received from the measurement sensors to the telemetry signal input requirements and also directs the conditioned signal to the proper telemetry system. R- and Z-calibration command circuitry is included in the signal conditioner unit. Z (zero) is equal to 15 percent of full-scale signal and R (range) is equal to 85 percent of full-scale signal.

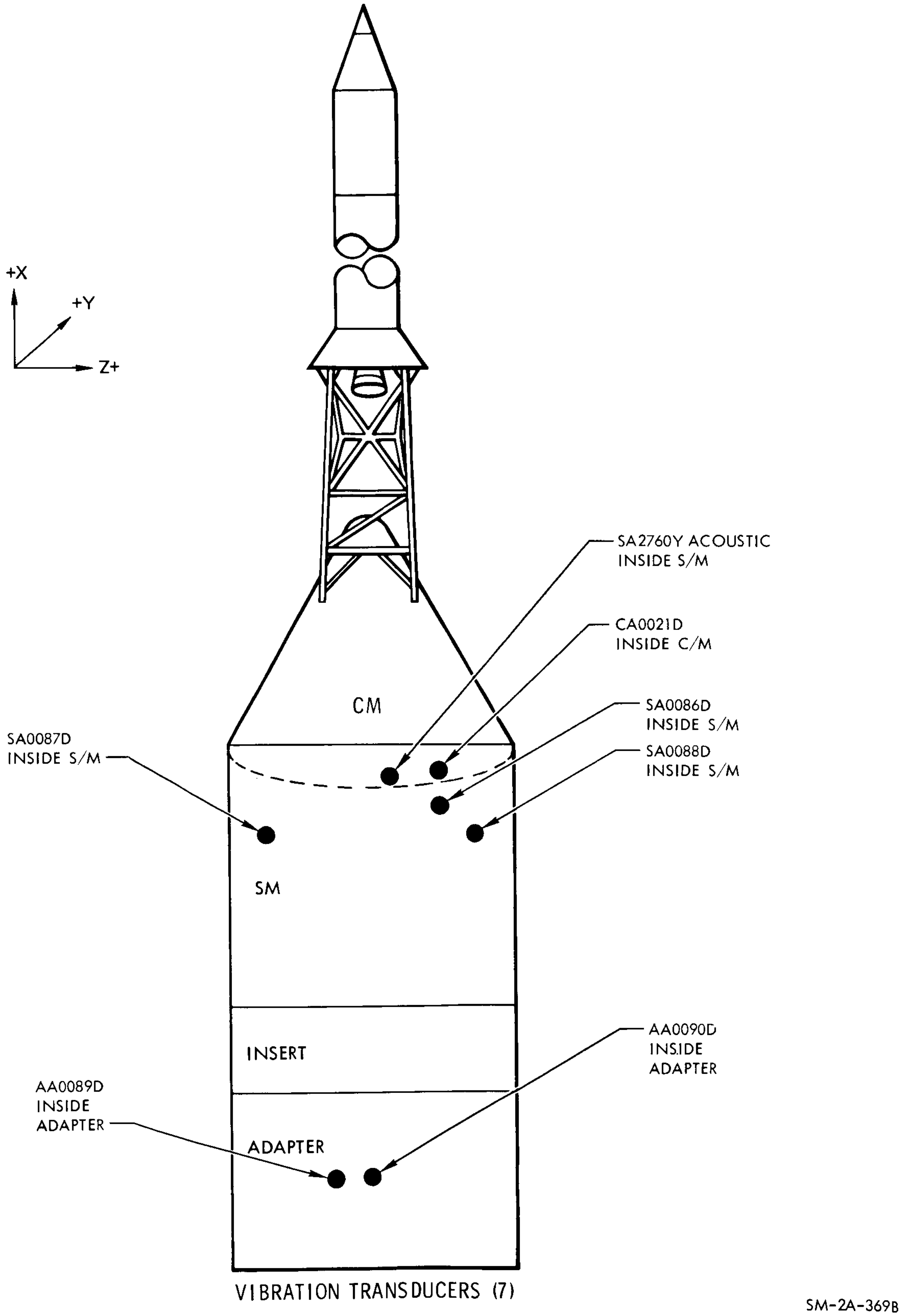


Figure 4-2. R&D Instrumentation Locations (Sheet 1 of 6)

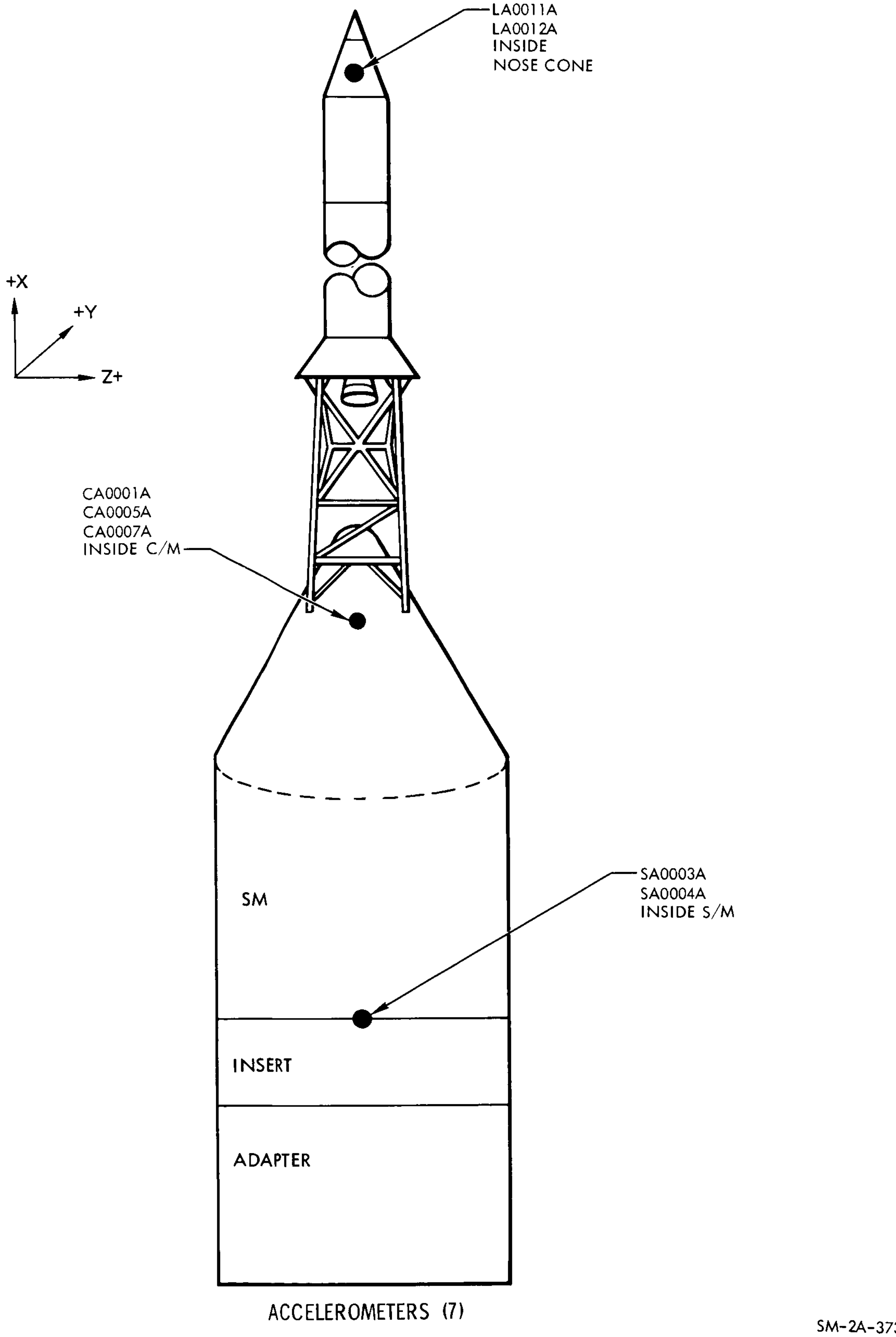


Figure 4-2. R&D Instrumentation Locations (Sheet 2 of 6)

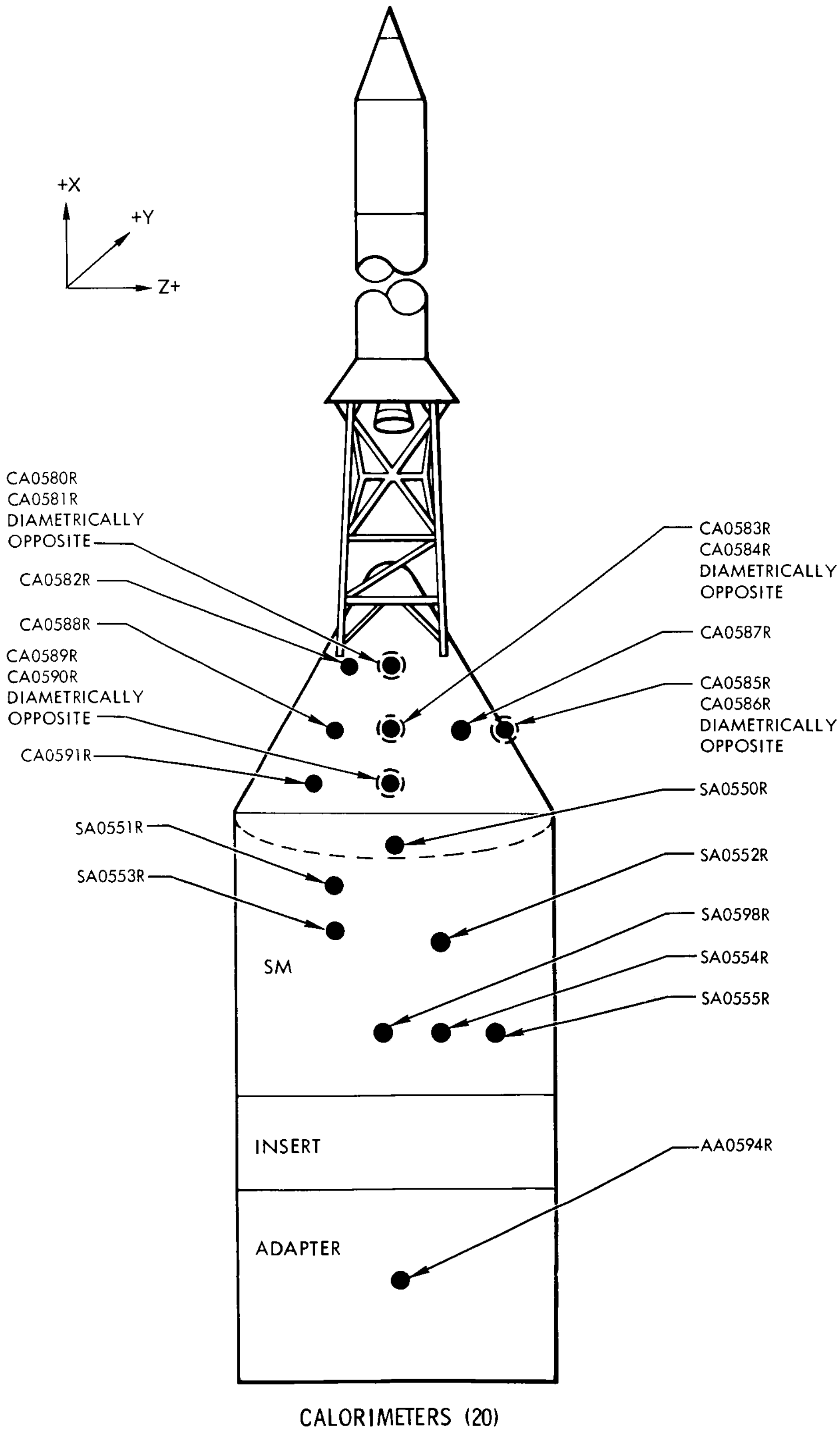


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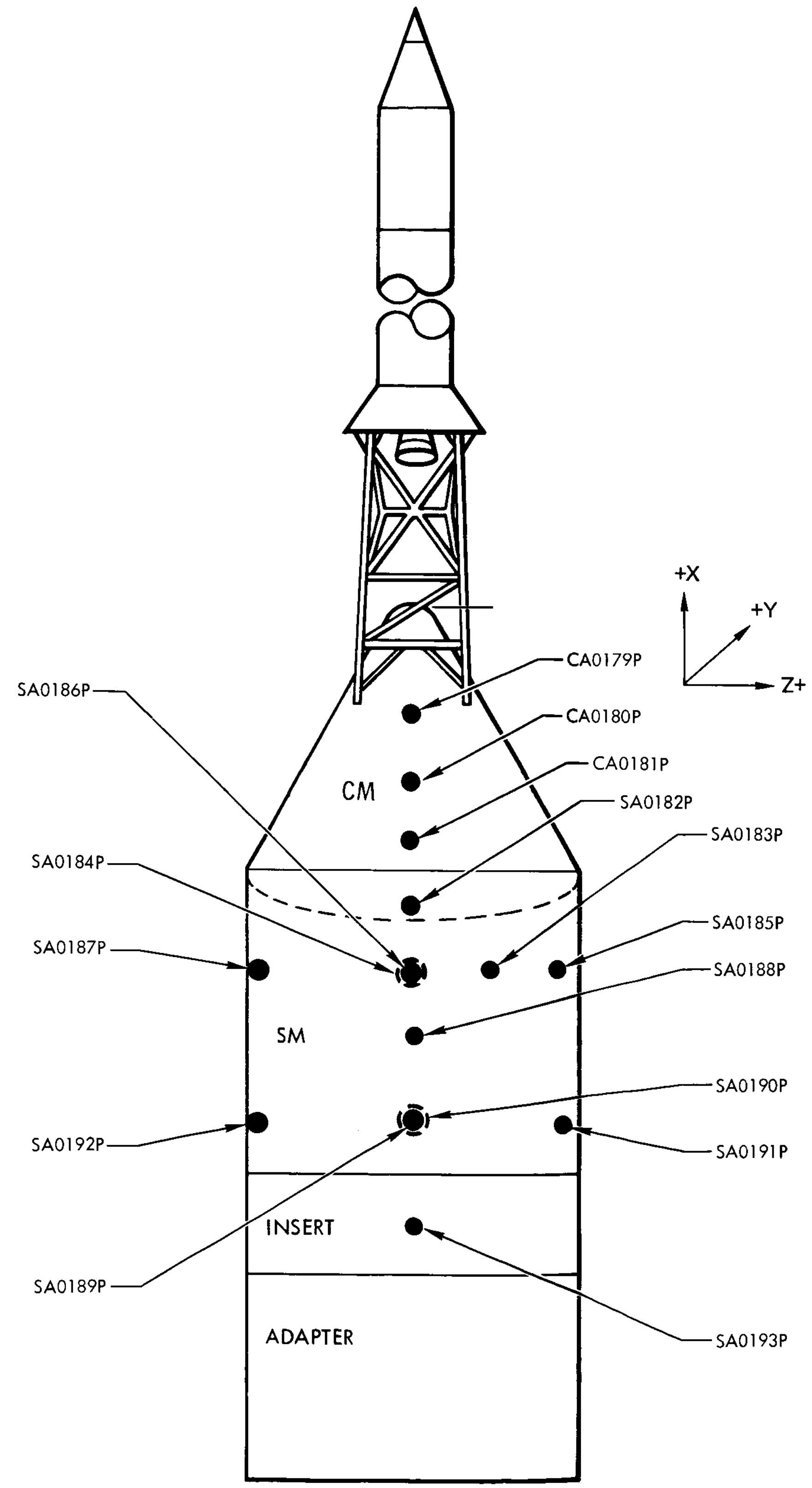
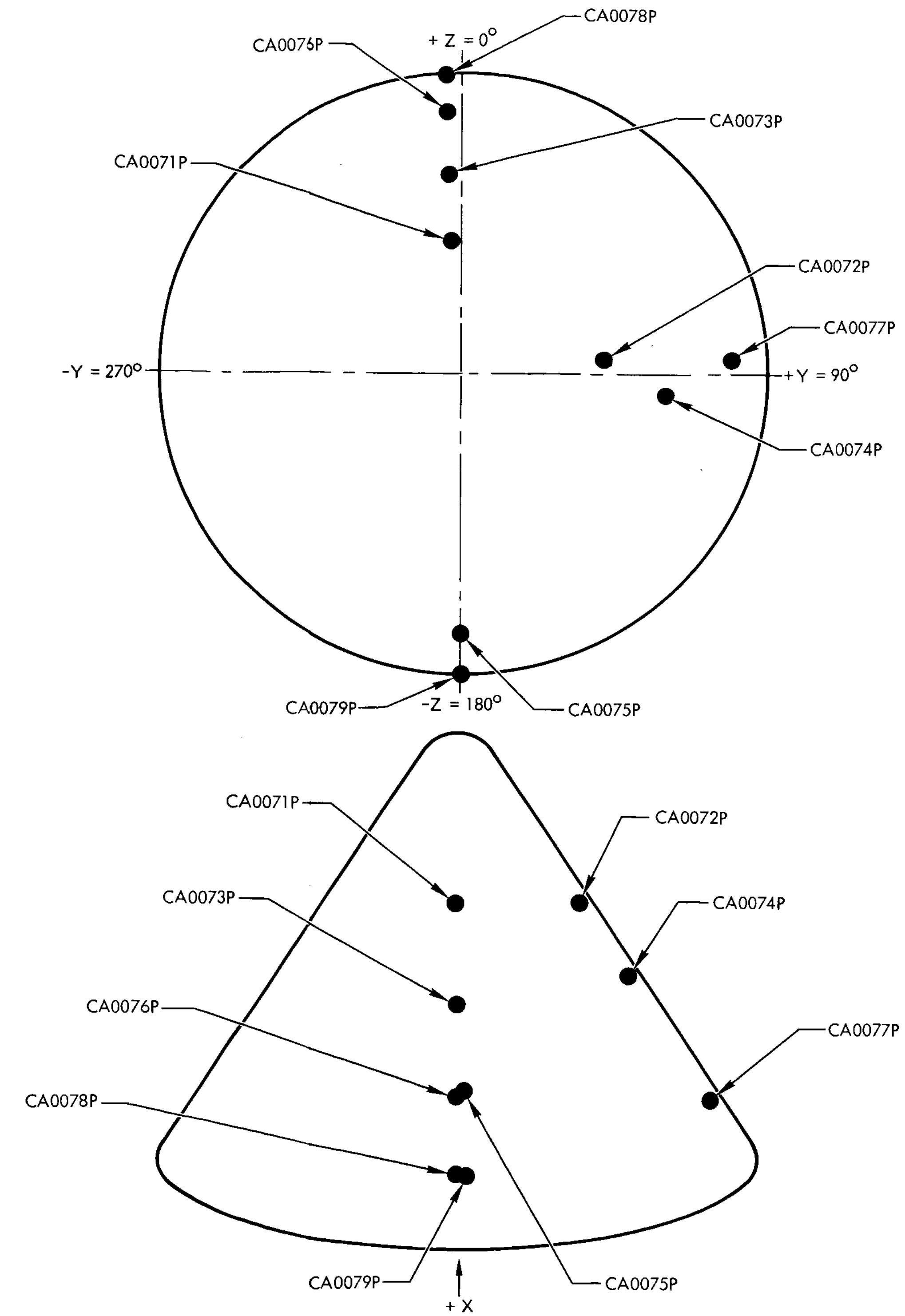
Figure 4-2. R&D Instrumentation Locations (Sheet 3 of 6)



FLUCTUATING PRESSURE TRANSDUCERS (15)



STATIC PRESSURE TRANSDUCERS (9)

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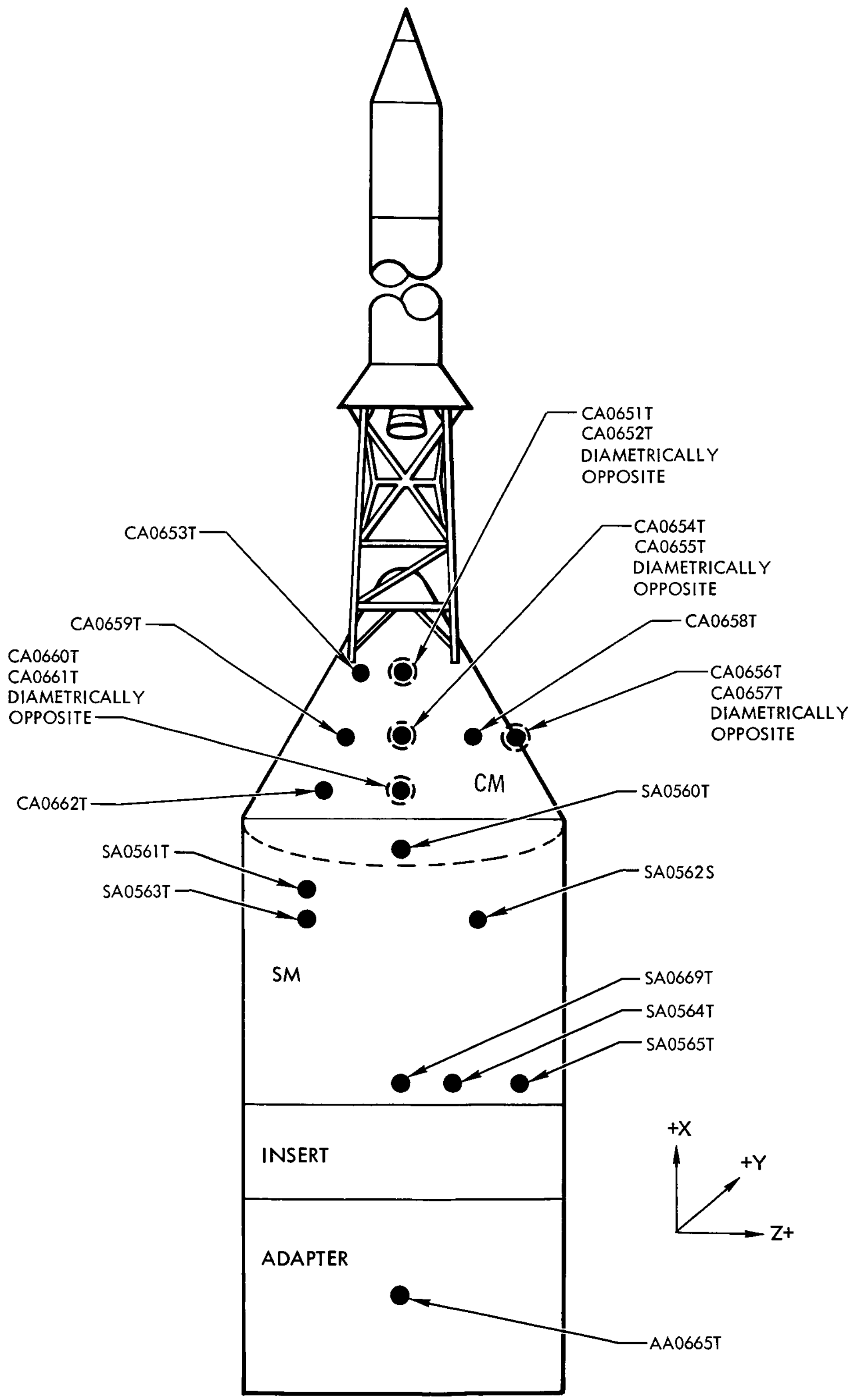
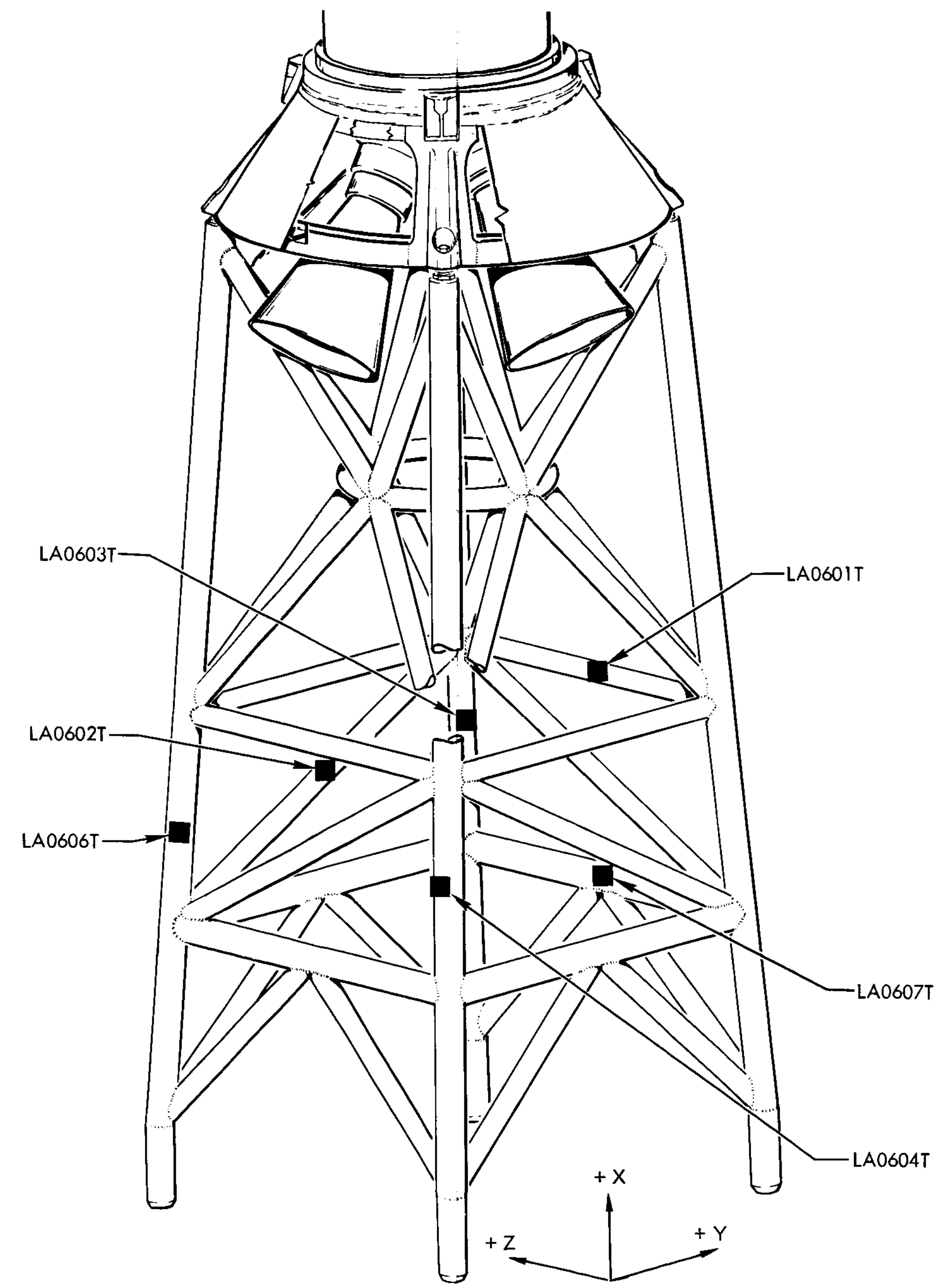
Figure 4-2. R&D Instrumentation Locations (Sheet 4 of 6)



CALORIMETER BODY TEMPERATURES (20)



TOWER TEMPERATURES (8)

SM-2A-370B

Figure 4-2. R&D Instrumentation Locations (Sheet 5 of 6)

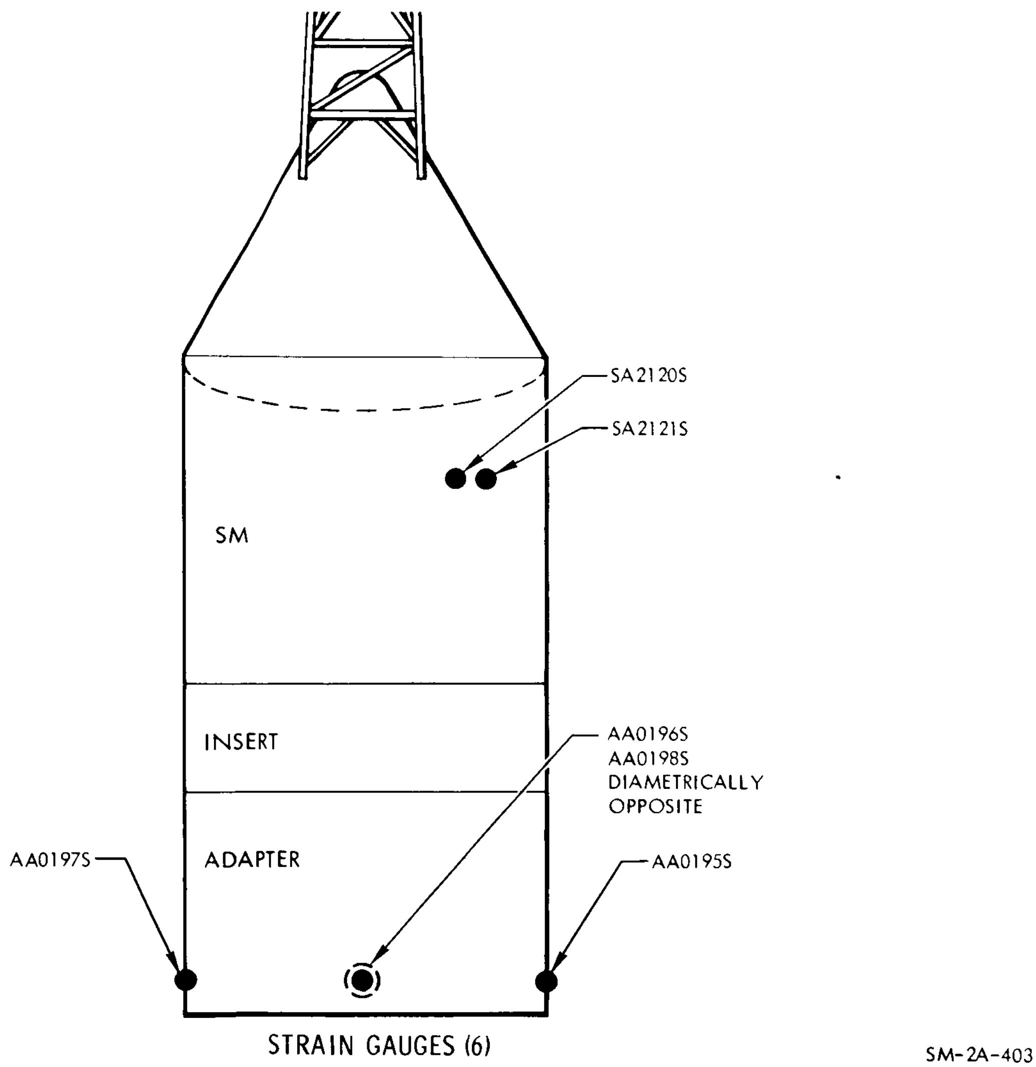


Figure 4-2. R&D Instrumentation Locations (Sheet 6 of 6)

4-14. VIBRATION SENSORS. Spacecraft radial vibrations are monitored by six piezo-electric accelerometers located in the command module (1), service module (3), and adapter (2). The sensor circuitry includes an amplifier which raises the signal to a level compatible with the required signal input of the voltage control oscillator. The two adapter sensors and an acoustical device (microphone) are located on the aerodynamic surface to determine extent of aerodynamic and engine noises during boost and staging phases. These signals are routed through the booster instrument unit.

4-15. STRAIN SENSORS. Four strain gages are mounted on the adapter stringer frame and two on the service module ring frame to determine spacecraft structural integrity under dynamic loads. The circuitry includes an amplifier which raises the signal to a level compatible with the required signal input level of the voltage control oscillators.

4-16. PRESSURE TRANSDUCERS. There are 25 pressure-sensing devices located in the spacecraft. Distribution and purpose of these devices is as follows:

a. One transducer in the command module monitors static cabin pressure.

b. Nine conical-surface pressure sensors are mounted about the command module exterior to determine the aerodynamic effects on the spacecraft verifying stability and loads.

c. Fifteen fluctuating-pressure transducers are located on the spacecraft, three in the command module and twelve in the service module. These measurements help to define boundary-layer noise, confirm environmental predications, and determine sonic-induced vibration response of the service module panels.

4-17. ACCELEROMETERS. Spacecraft acceleration measurements in all three planes are required to determine flight parameters and tower structure flight loads. Two accelerometers are mounted in the nose cone of the launch escape motor. One is assembled to measure acceleration along the Y-axis and the other is assembled to measure acceleration along the Z-axis. Three accelerometers are mounted in the command module so as to measure acceleration in all three planes and two are mounted in the service module to measure acceleration along the Y- and Z-axes.

4-18. VOLTAGE AND EVENT SIGNALS. Two voltage divider networks monitor the main bus d-c voltage. Voltage divider networks also monitor the voltage levels of the two logic and two pyro buses. This also provides events sequence information as to the time of arming the buses. Other events, which are sensed by relay closure, are jettison motor-ignition command and resultant tower separation, and tower-command module-separation commands from the booster guidance system. The purpose of the voltage measurements is to determine the electrical capability of the electrical power system and the mission sequencer during flight loading conditions. The purpose of the event signals is to demonstrate tower jettison sequencing.

4-19. Sensors are also provided to monitor the sequencer control S-I lift-off signal from the booster instrument unit and to monitor transponder trigger signals and transponder operation.

4-20. TEMPERATURE SENSORS. A temperature sensor is mounted in the interior of both the command module and service module to determine interior temperatures during flight loading conditions. Six resistance thermometers are mounted on the launch escape system tower structure members to determine aerodynamic heating. A thermocouple is mounted on each calorimeter to sense calorimeter body temperature for use in computing heat flow from the data provided by the 20 calorimeters. Telemetry transmitter and r-f amplifier environmental temperatures are monitored by two sensors mounted in each of the telemetry packages.

4-21. CALORIMETERS. Twenty calorimeters are located in the spacecraft to measure heating rates of various areas in order to adequately define aerodynamic heating of the spacecraft. Twelve are located about the command module surface, seven on the service module surface, and one on the adapter surface.

4-22. CURRENT SENSOR. A current sensor is located in the power control box. It monitors the total main power, direct-current flow during system loading to assist in determining the electrical capability and operation of the electrical power system.

4-23. Q-BALL. (See figures 4-3 and 4-4.) Three pressure transducers, with associated electronics and wiring, form the MSFC-furnished Q-ball system. Data provided by the Q-ball includes angle of attack, angle of sideslip, and dynamic ram pressures. The transducers sense airflow direction and pressure through ports in the Q-ball surface. The input voltage is 28 volts dc. This power is converted to 8 kilocycles AC for the transducer bridge and then rectified for amplifier power. The ac transducer signal is amplified and demodulated to provide the dc output. The output of the transducers is proportional to the three different pressures measured. The transducer outputs are routed to the booster instrumentation unit control computer and conditioned for booster telemetry. A heater is provided to prevent icing during prelaunch period and during flight up to Mach 2.

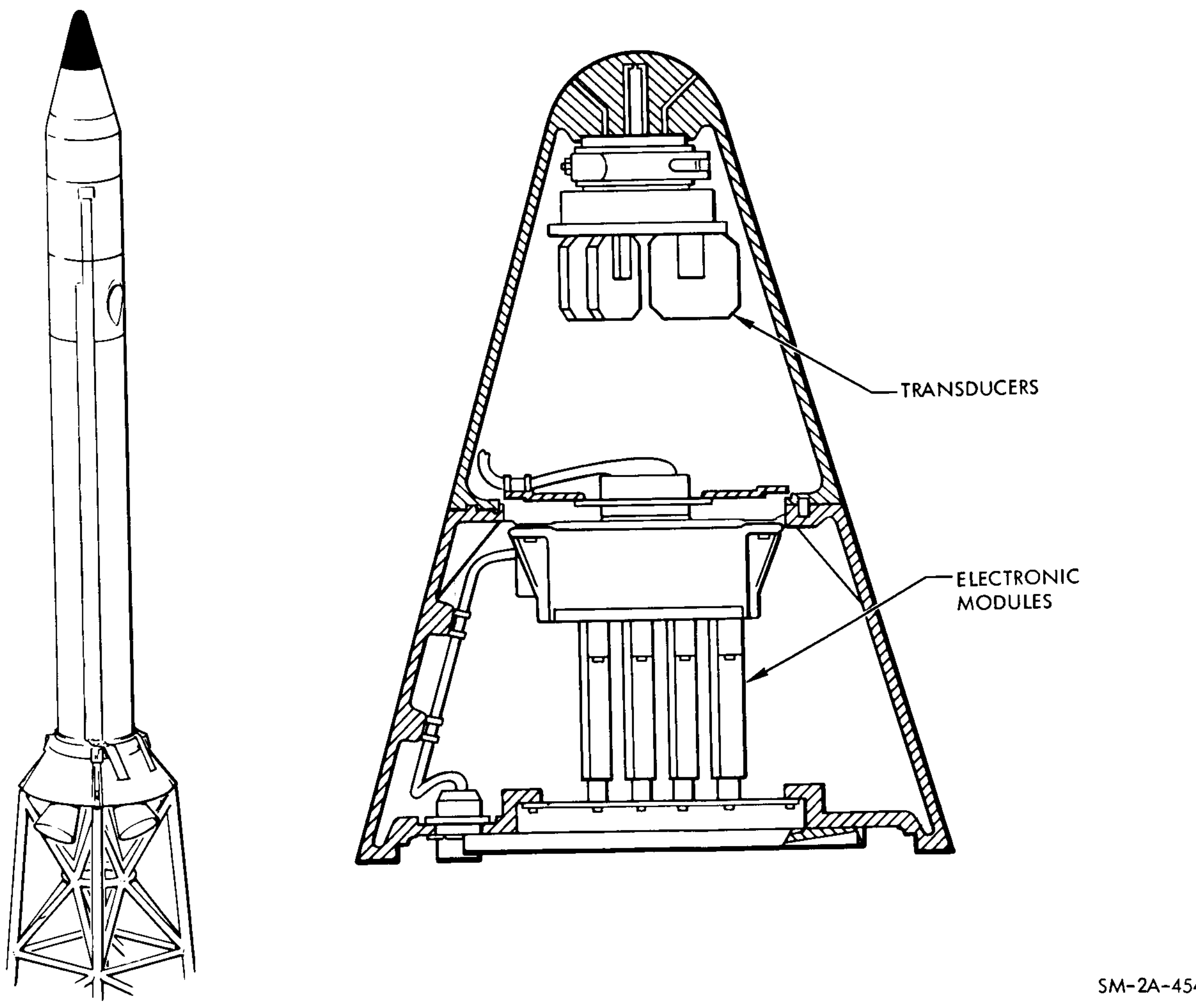


Figure 4-3. Q-Ball

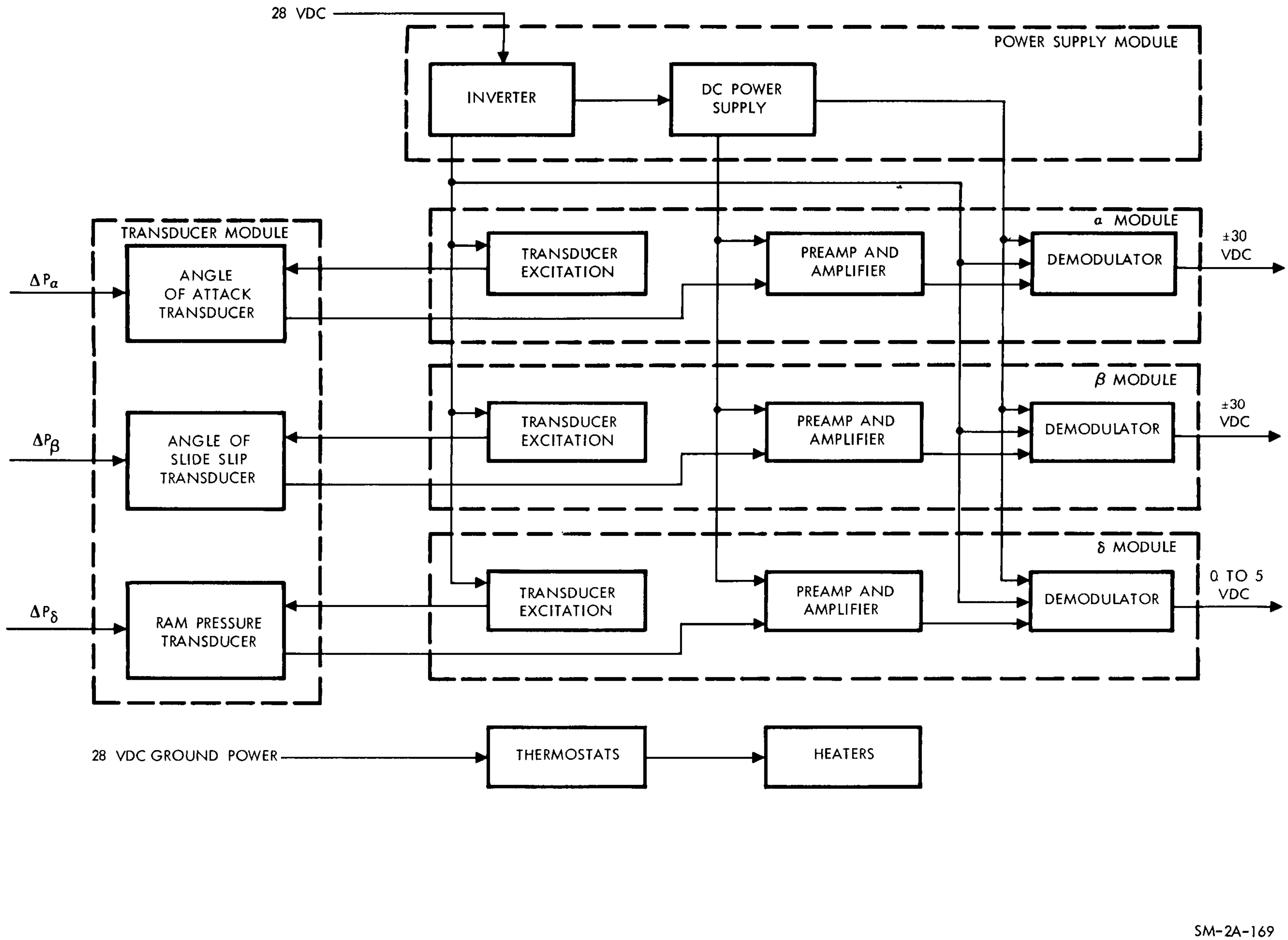


Figure 4-4. Q-Ball Block Diagram

[redacted]

Table 4-1. Measurement List

Meas. ID	Measurement Description	Channel L K	Channel SC No.	Channel Com Seg	Data Range Low	Data Range High	Data Range Unit	PR	Response Rate	Response Unit	Location
STRUCTURES											
CA0001A	X-Axis Spacecraft Accel High	C	8		-2	+10	G	P	0-30	cps	XC78, YC0, ZC21
SA0003A	Z-Axis Spacecraft Accel SM	C	7		-0.5	+0.5	G	P	0-20	cps	XA866, YA0, ZA73
SA0004A	Y-Axis Spacecraft Accel SM	A	6		-0.5	+0.5	G	P	0-20	cps	XA866, YA0, ZA73
CA0005A	Y-Axis Spacecraft Accel	C	6		-0.5	+0.5	G	P	0-20	cps	XC78, YC0, ZC21
CA0007A	Z-Axis Spacecraft Accel	B	6		-0.5	+0.5	G	P	0-20	cps	XC78, YC0, ZC21
LA0011A	Y-Axis Tower Accel	B	7		-2	+2	G	P	0-30	cps	XL380, YL0, ZL6
LA0012A	Z-Axis Tower Accel	B	8		-2	+2	G	P	0-30	cps	XL380, YL6, ZL0
CA0021D	CM Radial Vibration 1	A	16		-50	+50	G	P	20-1000	C	XC14, YC40.4, ZC37.3
CA0071P	Conical Surface Pressure 1	A	E	66	+0	+15	psia	M	10	S/S	XC76, 357 Deg
CA0072P	Conical Surface Pressure 2	A	E	67	+0	+15	psia	M	10	S/S	XC76, 87 Deg

[redacted]

Table 4-1. Measurement List (Cont)

Meas. ID	Measurement Description	Channel L K	Channel SC No.	Channel Com Seg	Data Range Low	Data Range High	Data Range Unit	PR	Response Rate	Response Unit	Location
STRUCTURES											
CA0073P	Conical Surface Pressure 3	A	E	68	+0	+15	psia	M	10	S/S	XC36, 357 Deg
CA0074P	Conical Surface Pressure 4	A	E	69	+0	+15	psia	M	10	S/S	XC36, 93 Deg
CA0075P	Conical Surface Pressure 5	A	E	70	+0	+15	psia	M	10	S/S	XC29, 180 Deg
CA0076P	Conical Surface Pressure 6	A	E	71	+0	+15	psia	M	10	S/S	XC27, 357 Deg
CA0077P	Conical Surface Pressure 7	A	E	72	+0	+15	psia	M	10	S/S	XC27, 87 Deg
CA0078P	Conical Surface Pressure 8	A	E	73	+0	+15	psia	M	10	S/S	XC20, 357 Deg
CA0079P	Conical Surface Pressure 9	A	E	74	+0	+15	psia	M	10	S/S	XC20, 180 Deg
SA0086D	SM Radial Vibration 2	C	18		-50	+50	G	P	20-1000	C	XA965.2, YA42.8, ZA-57
SA0087D	SM Radial Vibration 3	C	17		-50	+50	G	P	20-1000	C	XA953, YA-53.9, ZA47.7

Table 4-1. Measurement List (Cont)

Meas. ID	Measurement Description	Channel L K	Channel SC No.	Channel Com Seg	Data Range Low	Data Range High	Data Range Unit	PR	Response Rate	Response Unit	Location
STRUCTURES											
SA0088D	SM Radial Vibration 4	B	17		-50	+50	G	P	20-1000	C	XA940.4, YA68.3, ZA22.8
AA0089D	Adapter Radial Vibration 5	LV	TM		-50	+50	G	P	25-2000	C	XA777.7, YA0, ZA72
AA0090D	Adapter Radial Vibration 6	LV	TM		-50	+50	G	P	25-2000	C	XA777.7, YA-15.5, ZA71
CA0179P	Fluctuating Pressure 1	B	18		+0	+15	psia	M	1000	cps	XC100, 357 Deg
CA0180P	Fluctuating Pressure 2	C	15		+0	+15	psia	M	300	cps	XC70, 357 Deg
CA0181P	Fluctuating Pressure 3	B	15		+0	+15	psia	M	300	cps	XC40, 357 Deg
SA0182P	Fluctuating Pressure 4	A	15		+0	+15	psia	M	300	cps	XC12, 357 Deg
SA0183P	Fluctuating Pressure 5	C	14		+0	+15	psia	M	300	cps	XA974, 43 Deg
SA0184P	Fluctuating Pressure 6	B	14		+0	+15	psia	M	300	cps	XA974, 357 Deg

Table 4-1. Measurement List (Cont)

Meas. ID	Measurement Description	Channel L K	Channel SC No.	Channel Com Seg	Data Range Low	Data Range High	Data Range Unit	PR	Response Rate	Response Unit	Location
STRUCTURES											
SA0185P	Fluctuating Pressure 7	A	14		+0	+15	psia	M	300	cps	XA974, 87 Deg
SA0186P	Fluctuating Pressure 8	C	13		+0	+15	psia	M	300	cps	XA974, 177 Deg
SA0187P	Fluctuating Pressure 9	B	13		+0	+15	psia	M	300	cps	XA974, 267 Deg
SA0188P	Fluctuating Pressure 10	A	12		+0	+15	psia	M	300	cps	XA930, 357 Deg
SA0189P	Fluctuating Pressure 11	C	12		+0	+15	psia	M	300	cps	XA881, 357 Deg
SA0190P	Fluctuating Pressure 12	B	12		+0	+15	psia	M	300	cps	XA881, 177 Deg
SA0191P	Fluctuating Pressure 13	A	11		+0	+15	psia	M	300	cps	XA881, 87 Deg
SA0192P	Fluctuating Pressure 14	B	11		+0	+15	psia	M	300	cps	XA881, 267 Deg
SA0193P	Fluctuating Pressure 15	B	11		+0	+15	psia	M	300	cps	XA833, 357 Deg
AA0195S	Strain 1 Adapter	A	9		-1000	+1000	UI/IN	M	100	cps	XA736, YA76, ZA0

[redacted]

Table 4-1. Measurement List (Cont)

Meas. ID	Measurement Description	Channel L K	Channel SC No.	Channel Com Seg	Data Range Low	Data Range High	Data Range Unit	PR	Response Rate	Response Unit	Location
STRUCTURES											
AA0196S	Strain 2 Adapter	A	10		-1000	+1000	UI/IN	M	100	cps	XA736, YA0, ZA-76
AA0197S	Strain 3 Adapter	B	10		-1000	+1000	UI/IN	M	100	cps	XA736, YA-76, ZA0
AA0198S	Strain 4 Adapter	C	10		-1000	+1000	UI/IN	M	100	cps	XA736, YA0, ZA76
SA0550R	Heat Flux (Calorimeter) 17	A	13	28	+0	+5	B/F/S		1.25	S/S	XS338, 183 Deg
SA0551R	Heat Flux (Calorimeter) 18	A	13	29	+0	+5	B/F/S		1.25	S/S	XS315, 187.2 Deg
SA0552R	Heat Flux (Calorimeter) 20	A	13	31	+0	+5	B/F/S		1.25	S/S	XS305, 177 Deg
SA0553R	Heat Flux (Calorimeter) 13	A	13	24	+0	+5	B/F/S		1.25	S/S	XS305, 187.2 Deg
SA0554R	Heat Flux (Calorimeter) 14	A	13	25	+0	+5	B/F/S		1.25	S/S	XS267, 160 Deg
SA0555R	Heat Flux (Calorimeter) 16	A	13	27	+0	+5	B/F/S		1.25	S/S	XS267, 145 Deg
SA0560T	Calorimeter Body Temp 17	A	13	48	+0	+300	Deg C		1.25	S/S	XS338, 183 Deg

Table 4-1. Measurement List (Cont)

Meas. ID	Measurement Description	Channel L K	Channel SC No.	Channel Com Seg	Data Range Low	Data Range High	Data Range Unit	PR	Response Rate	Response Unit	Location
STRUCTURES											
AS0561T	Calorimeter Body Temp 18	A	13	49	+0	+300	Deg C		1.25	S/S	XS315, 187.2 Deg
SA0562T	Calorimeter Body Temp 20	A	13	51	+0	+300	Deg C		1.25	S/S	XS305, 177 Deg
SA0563T	Calorimeter Body Temp 13	A	13	44	+0	+300	Deg C		1.25	S/S	XS305, 187.2 Deg
SA0564T	Calorimeter Body Temp 14	A	13	45	+0	+300	Deg C		1.25	S/S	XS267, 160 Deg
SA0565T	Calorimeter Body Temp 16	A	13	47	+0	+300	Deg C		1.25	S/S	XS267, 145 Deg
CA0580R	Heat Flux (Calorimeter) 1	A	13	12	+0	+25	B/F/S	M	1.25	S/S	XC74, 3 Deg
CA0581R	Heat Flux (Calorimeter) 2	A	13	13	+0	+25	B/F/S	M	1.25	S/S	XC74, 180 Deg
CA0582R	Heat Flux (Calorimeter) 3	A	13	14	+0	+25	B/F/S	M	1.25	S/S	XC74, 319 Deg
CA0583R	Heat Flux (Calorimeter) 4	A	13	15	+0	+25	B/F/S	M	1.25	S/S	XC53, 180 Deg
CA0584R	Heat Flux (Calorimeter) 5	A	13	16	+0	+25	B/F/S	M	1.25	S/S	XC52, 3 Deg

Table 4-1. Measurement List (Cont)

Meas. ID	Measurement Description	Channel L K	Channel SC No.	Channel Com Seg	Data Range Low	Data Range High	Data Range Unit	PR	Response Rate	Response Unit	Location
STRUCTURES											
CA0585R	Heat Flux (Calorimeter) 6	A	13	17	+0	+25	B/F/S	M	1.25	S/S	XC52, 80 Deg
CA0586R	Heat Flux (Calorimeter) 7	A	13	18	+0	+25	B/F/S	M	1.25	S/S	XC52, 85 Deg
CA0587R	Heat Flux (Calorimeter) 8	A	13	19	+0	+25	B/F/S	M	1.25	S/S	XC52, 95 Deg
CA0588R	Heat Flux (Calorimeter) 9	A	13	20	+0	+25	B/F/S	M	1.25	S/S	XC52, 319 Deg
CA0589R	Heat Flux (Calorimeter) 10	A	13	21	+0	+25	B/F/S	M	1.25	S/S	XC42, 65 Deg
CA0590R	Heat Flux (Calorimeter) 11	A	13	22	+0	+25	B/F/S	M	1.25	S/S	XC27, 180 Deg
CA0591R	Heat Flux (Calorimeter) 12	A	13	23	+0	+25	B/F/S	M	1.25	S/S	XC27, 319 Deg
AA0594R	Heat Flux (Calorimeter) 19	A	13	30	+0	+5	B/F/S	M	1.25	S/S	XA770, 183 Deg
SA0598R	Heat Flux (Calorimeter) 15	A	13	26	+0	+5	B/F/S	M	1.25	S/S	XA933, 183 Deg

Table 4-1. Measurement List (Cont)

Meas. ID	Measurement Description	Channel			Data Range			PR	Response		Location
		L K	SC No.	Com Seg	Low	High	Unit		Rate	Unit	
STRUCTURES											
LA0601T	Tower Temperature 2	A	13	53	+0	+150	Deg C	M	1.25	S/S	XL61, YL22, ZL0
LA0602T	Tower Temperature 3	A	13	54	+0	+150	Deg C	M	1.25	S/S	SL47, YL0, ZL23
LA0603T	Tower Temperature 4	A	13	55	+0	+150	Deg C	M	1.25	S/S	XL47, YL24, ZL23
LA0604T	Tower Temperature 5	A	13	56	+0	+150	Deg C	M	1.25	S/S	XL47, YL-24, ZL-23
LA0606T	Tower Temperature 7	A	13	58	+0	+150	Deg C	M	1.25	S/S	XL47, YL-24, ZL23
LA0607T	Tower Temperature 8	A	13	59	+0	+150	Deg C	M	1.25	S/S	XL36, YL24, ZL0
CA0610T	CM Interior Temp	A	13	4	+0	+150	Deg C	S	1.25	S/S	CM Interior
CA0611P	CM Interior Press	A	E	88	+0	+15	Psia	S	10	S/S	CM Interior
SA0612T	SM Interior Temp	A	13	5	+0	+150	Deg C	S	1.25	S/S	SM Interior

Table 4-1. Measurement List (Cont)

Meas. ID	Measurement Description	Channel L K	Channel SC No.	Channel Com Seg	Data Range Low	Data Range High	Data Range Unit	PR	Response Rate	Response Unit	Location
STRUCTURES											
CA0651T	Calorimeter Body Temp 1	A	13	32	+0	+300	Deg C	S	1.25	S/S	XC74, 3 Deg
CA0652T	Calorimeter Body Temp 2	A	13	33	+0	+300	Deg C	S	1.25	S/S	XC74, 180 Deg
CA0653T	Calorimeter Body Temp 3	A	13	34	+0	+300	Deg C	S	1.25	S/S	XC74, 319 Deg
CA0654T	Calorimeter Body Temp 4	A	13	35	+0	+300	Deg C	S	1.25	S/S	XC53, 180 Deg
CA0655T	Calorimeter Body Temp 5	A	13	36	+0	+300	Deg C	S	1.25	S/S	XC52, 3 Deg
CA0656T	Calorimeter Body Temp 6	A	13	37	+0	+300	Deg C	S	1.25	S/S	XC52, 80 Deg
CA0657T	Calorimeter Body Temp 7	A	13	38	+0	+300	Deg C	S	1.25	S/S	XC52, 85 Deg
CA0658T	Calorimeter Body Temp 8	A	13	39	+0	+300	Deg C	S	1.25	S/S	XC52, 95 Deg
CA0659T	Calorimeter Body Temp 9	A	13	40	+0	+300	Deg C	S	1.25	S/S	XC52, 319 Deg

Table 4-1. Measurement List (Cont)

Meas. ID	Measurement Description	Channel L K	Channel SC No.	Channel Com Seg	Data Range Low	Data Range High	Data Range Unit	PR	Response Rate	Response Unit	Location
					STRUCTURES						
CA0660T	Calorimeter Body Temp 10	A	13	41	+0	+300	Deg C	S	1.25	S/S	XC27, 3 Deg
CA0661T	Calorimeter Body Temp 11	A	13	42	+0	+300	Deg C	S	1.25	S/S	XC42.65,180 Deg
CA0662T	Calorimeter Body Temp 12	A	13	43	+0	+300	Deg C	S	1.25	S/S	XC27, 319 Deg
AA0665T	Calorimeter Body Temp 19	A	13	50	+0	+300	Deg C	S	1.25	S/S	XA770, 183 Deg
SA0669T	Calorimeter Body Temp 15	A	13	46	+0	+300	Deg C	S	1.25	S/S	XA933, 183 Deg
SA2120S	Strain 1 Service Module	B	16		-4000	+4000	UI/IN	M	250	cps	XA940.4, 62.25 Deg
SA2121S	Strain 2 Service Module	C	16		-4000	+4000	UI/IN	M	250	cps	XA940.4, 77.25 Deg
SA2760Y	Service Module Acoustic	LV	TM		+150	+170	db	S	25-3000	C	XS339, 0 Deg

Table 4-1. Measurement List (Cont)

Meas. ID	Measurement Description	Channel L K	Channel SC No.	Channel Com Seg	Data Range Low	Data Range High	Data Range Unit	PR	Response Rate	Response Unit	Location
	ELECTRICAL SYSTEM										
CC0001V	DC Voltage Main Bus A	A	E	24	+22	+32	vdc	P	10	S/S	Pwr Control Box
CC0002V	DC Voltage Main Bus B	A	E	25	+22	+32	vdc	P	10	S/S	Pwr Control Box
CC0003V	DC Voltage Logic Bus A	A	E	22	+0	+36	vdc	P	10	S/S	LES Sequencer
CC0004V	DC Voltage Logic Bus B	A	E	23	+0	+36	vdc	P	10	S/S	LES Sequencer
CC0005C	Total DC Current	A	E	26	+0	+50	amps	P	10	S/S	Pwr Control Box
	LAUNCH ESCAPE SYSTEM										
BD0001X	S-I Lift Off Signal	A-9	A-10				Step	M	100	cps	Sig Cond Box
LD0033X	Twr Jett and Sep Relay Close A	A	E	29			Step	P	10	S/S	Twr LES Sequencer
LD0034X	Twr Jett and Sep Relay Close B	A	E	29			Step	P	10	S/S	Twr LES Sequencer
CD0039V	S-I Sep Signal A	A	E	37	+0	+36	vdc	P	10	S/S	LES Sequencer

Table 4-1. Measurement List (Cont)

Meas. ID	Measurement Description	Channel L K	Channel SC No.	Channel Com Seg	Data Range Low	Data Range High	Data Range Unit	PR	Response Rate	Response Unit	Location
LAUNCH ESCAPE SYSTEM											
CD0040V	S-I Sep Signal B	A	E	38	+0	+36	vdc	P	10	S/S	LES Sequencer
CD0185V	DC Voltage Twr Pyro Bus A	A	E	28	+0	+36	vdc	P	10	S/S	LES Sequencer
CD0186V	DC Voltage Twr Pyro Bus B	A	E	35	+0	+36	vdc	P	10	S/S	LES Sequencer
COMMUNICATIONS AND INSTRUMENTATION SYSTEM											
CT0002V	Transponder A Trigger	A	E	57	+0	+5	vdc	S	10	S/S	Transponder A
CT0003V	Transponder B Trigger	A	E	58	+0	+5	vdc	S	10	S/S	Transponder B
CT0007X	R and Z Calibration Monitor	A	E	59			Step	P	10	S/S	Sig Cond Box
CT0201T	TM RF XMTR A Temp	A	13	6	+0	+150	Deg C	S	1.25	S/S	TM RF XMTR A
CT0202T	TM RF AMP A Temp	A	13	7	+0	+150	Deg C	S	1.25	S/S	TM RF AMP A

Table 4-1. Measurement List (Cont)

Meas. ID	Measurement Description	Channel L K	Channel SC No.	Channel Com Seg	Data Range Low	Data Range High	Data Range Unit	PR	Response Rate	Response Unit	Location
COMMUNICATIONS AND INSTRUMENTATION SYSTEM											
CT0203T	TM RF XMTR B Temp	A	13	8	+0	+150	Deg C	S	1.25	S/S	TM RF XMTR B
CT0204T	TM RF AMP B Temp	A	13	9	+0	+150	Deg C	S	1.25	S/S	TM RF AMP B
CT0205T	TM RF XMTR C Temp	A	13	10	+0	+150	Deg C	S	1.25	S/S	TM RF XMTR C
CT0207T	TM RF AMP C Temp	A	13	11	+0	+150	Deg C	S	1.25	S/S	TM RF AMP C

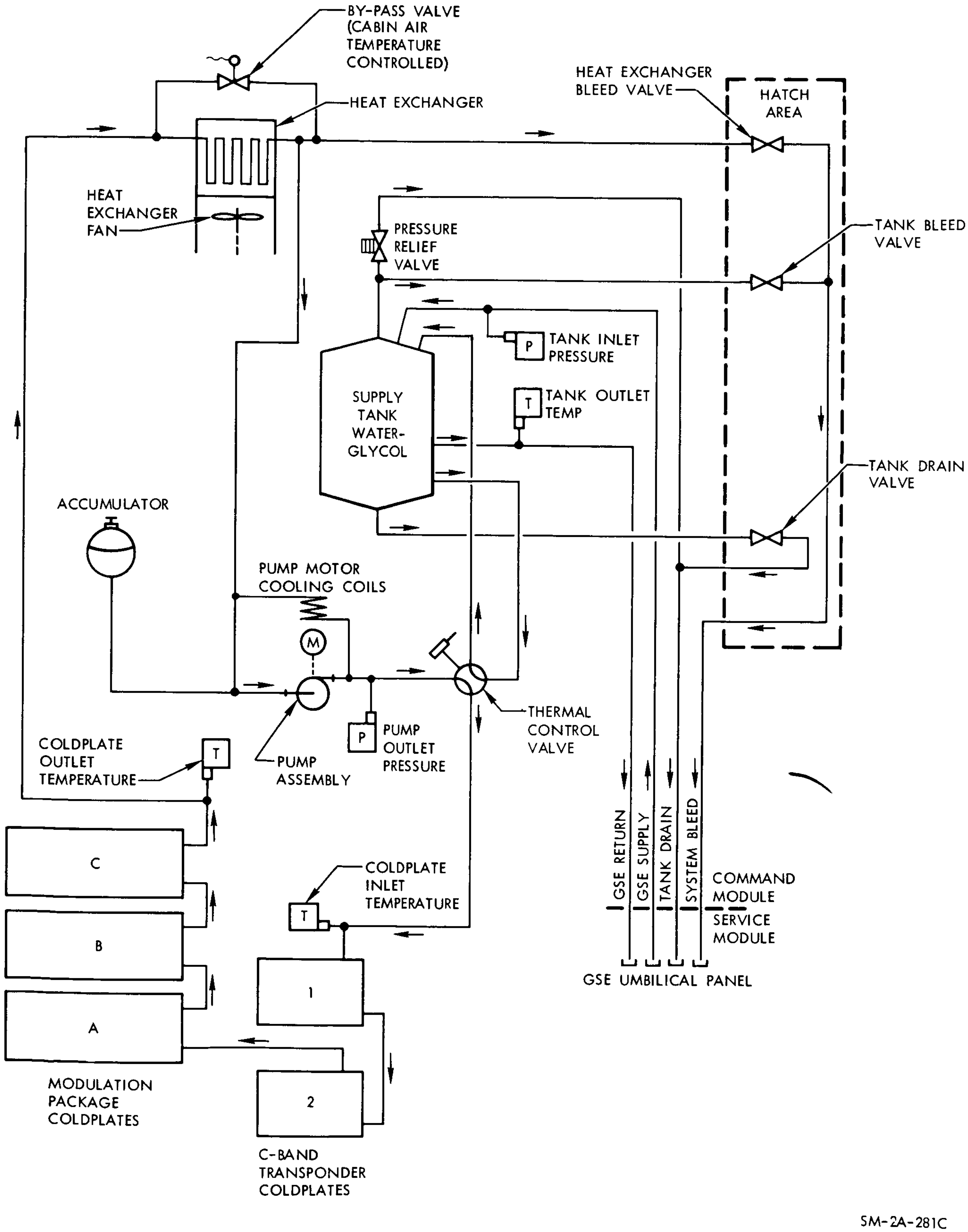


Figure 5-2. Equipment Cooling System Schematic Diagram

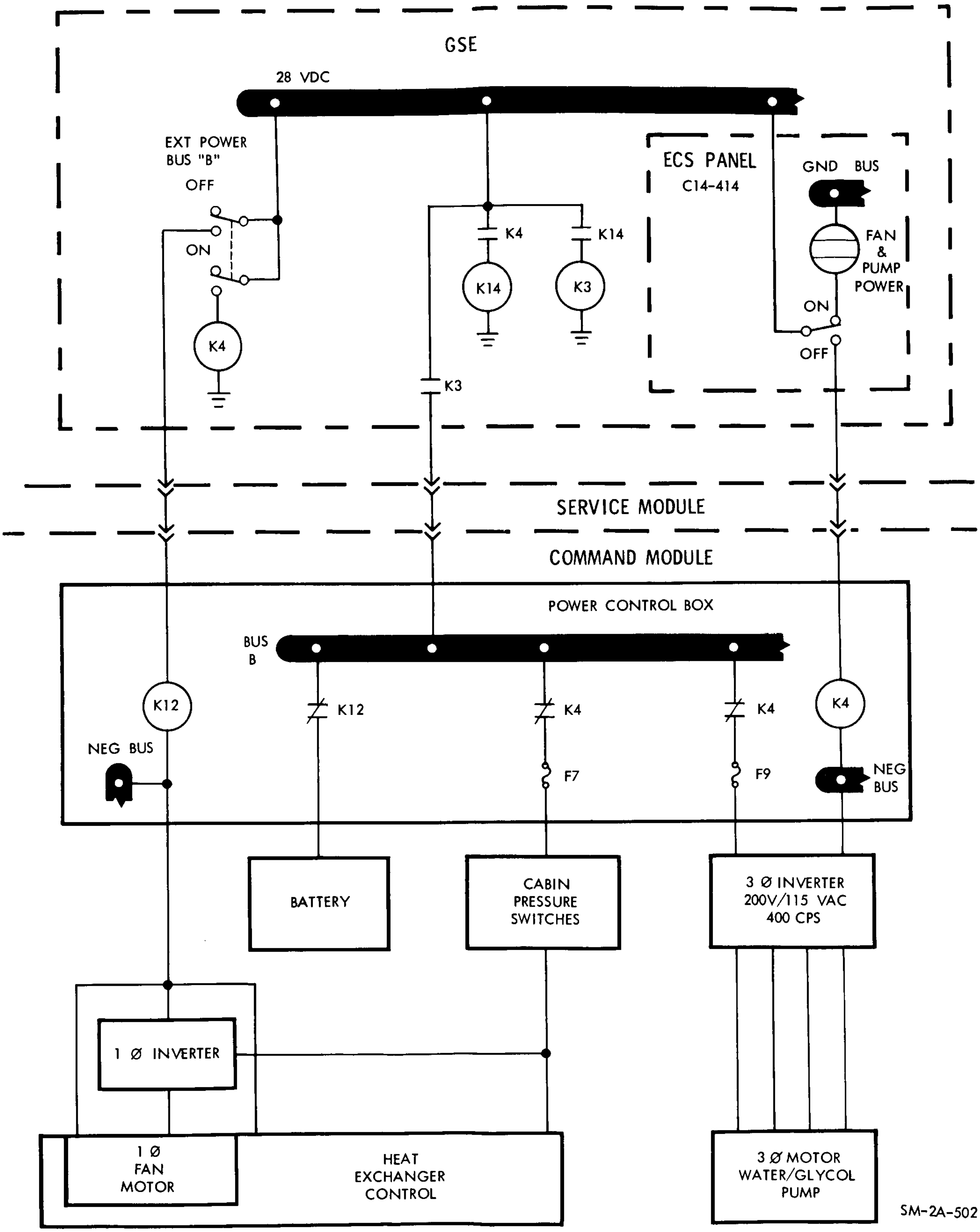


Figure 5-3. Equipment Cooling System Electrical Schematic (Sheet 1 of 2)

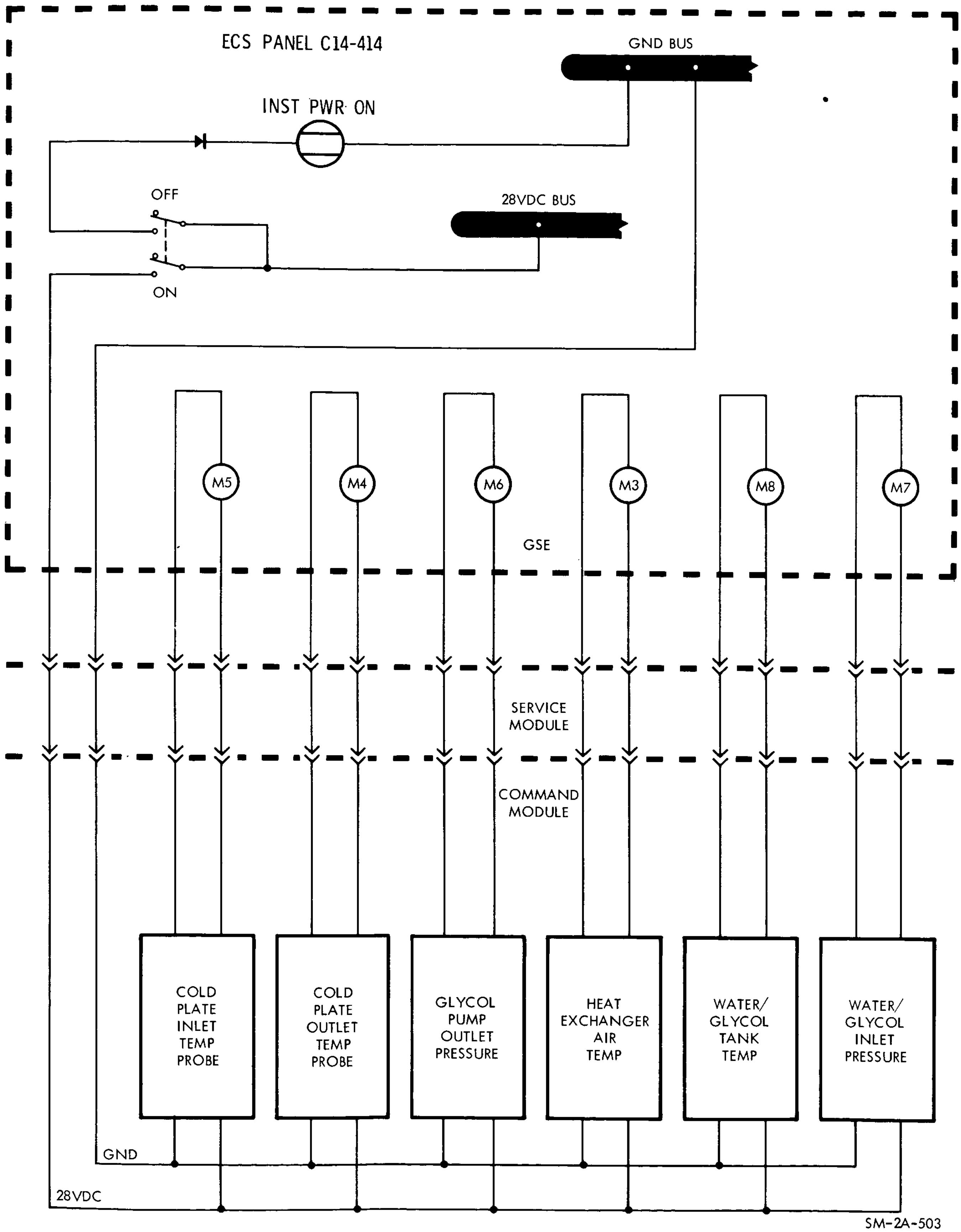


Figure 5-3. Equipment Cooling System Electrical Schematic (Sheet 2 of 2)

5-7. OPERATION ON THE LAUNCH PAD. Ground support equipment furnishes water-glycol at 20°F to spacecraft via umbilical disconnect. The coolant continually flows into the tank, exciting the fluid in the tank, and back out the outlet line for return to the GSE. The supply line and return line to the ground support equipment is disconnected automatically by an umbilical disconnect. Pressure transducers are installed at the pump outlet and glycol tank inlet for checking system pressure. Temperature sensors are installed in the lines at the inlet side of the modulation package coldplates, at the inlet side of the heat exchanger, at the outlet side of the glycol tank, and at the heat exchanger solenoid. This instrumentation is provided for ground monitoring only. (See figures 5-1 and 5-2.)

SECTION VI

ELECTRICAL POWER SYSTEM

6-1. PURPOSE.

6-2. The electrical power system supplies power to all operational units of the communications and instrumentation system for switching and distribution of events that occur during a mission. It also provides switching arrangement for event distribution to the signal conditioning unit and operating and monitoring power for launch escape system functions.

6-3. SYSTEM EQUIPMENT.

6-4. The electrical power system consists of six multi-cell, silver, zink-oxide batteries, a power control box, a junction box, and associated wire harnesses. These units are located on the equipment racks of the command module. Table 6-1 contains the physical characteristics of the batteries.

Table 6-1. Battery Physical Characteristics

Main Batteries: (Instrumentation)	
Height	9.50 inches
Width	6.36 inches
Length	9.05 inches
Weight	52 pounds
Nominal voltage	28 volts
Capacity	120 ampere hours
Electrolyte	Potassium hydroxide
Pyro and Logic Batteries:	
Height	3.52 inches
Width	4.69 inches
Length	7.00 inches
Weight	7.6 pounds
Nominal voltage	28 volts
Capacity	5 ampere hours
Electrolyte	Potassium hydroxide

6-5. PRINCIPLES OF OPERATION. (See figure 6-1.)

6-6. The main batteries (NASA-furnished) provide the electrical power required to energize the instrumentation devices and telemetry equipment such as sensors, and amplifiers. The main batteries supply power to bus A and B of the power control box through normally closed contacts of the internal A and B power control relays. These relays can only be energized by GSE action. The power control relays remain open when power is being supplied by GSE to preserve the battery power prior to umbilical disconnect. Power transfer is accomplished manually. When GSE is disconnected (at lift-off), the power control relays close and system power is supplied by the on-board batteries.

6-7. The pyro batteries provide electrical power to energize the tower separation system components. Redundant circuits provide the high reliability required to assure a successful mission.

6-8. The logic batteries provide electrical power to energize control circuitry of the mission sequencer. Redundant circuits provide the high reliability required to assure a successful mission.

6-9. POWER CONSUMPTION.

6-10. Optimum power requirements by system are as follows:

a. Equipment cooling system — 396 watts (mission)

b. Communications and instrumentation System — 924 watts (mission)

c. Launch Escape System:

1. Tower jettison motor squibs — 18 watts (for 20 milliseconds)

2. Tower leg separation squibs — 72 watts (for 20 milliseconds)

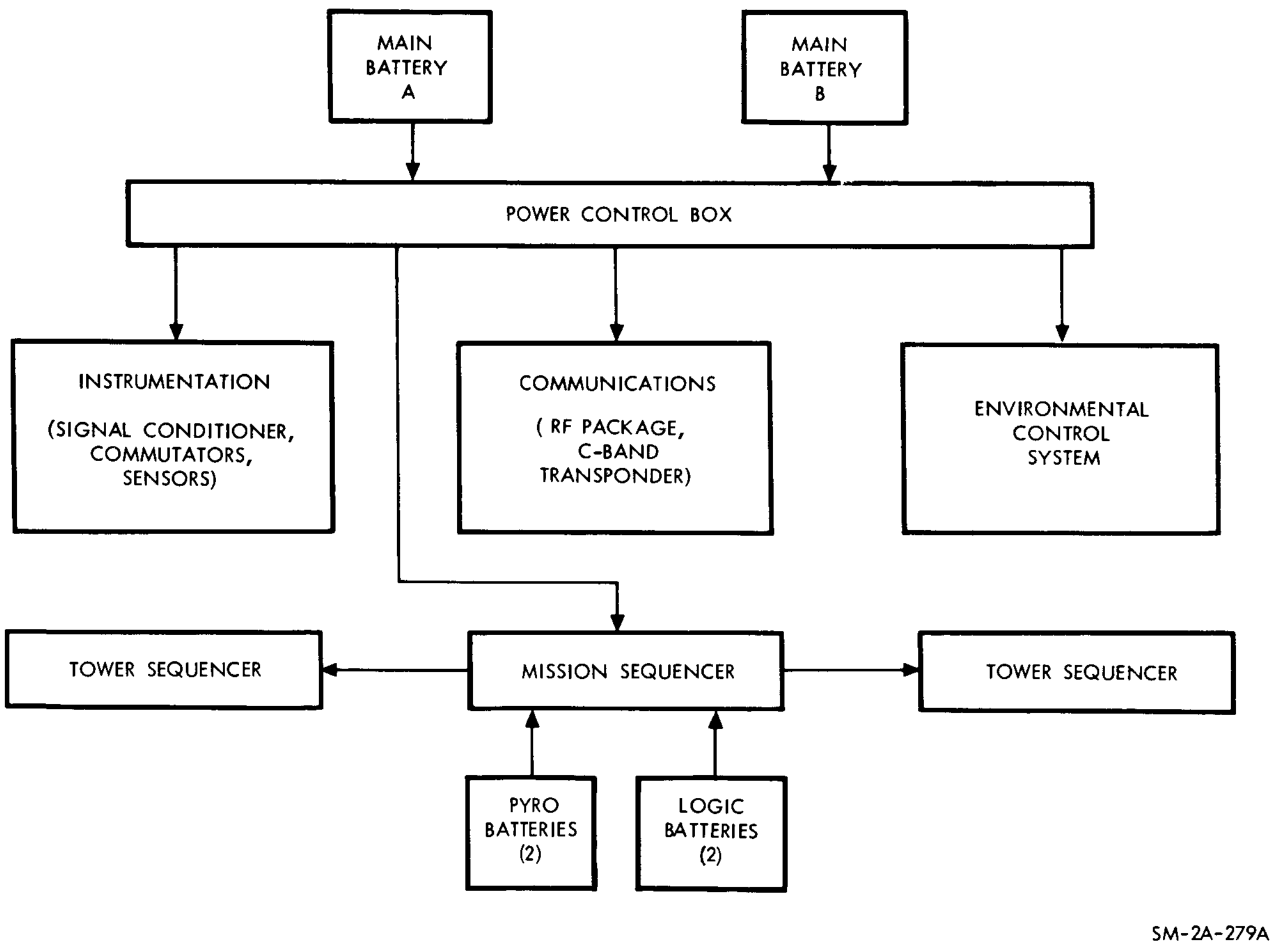


Figure 6-1. Electrical Power System Block Diagram

SECTION VII

DOCUMENTATION AND SUPPORTING EQUIPMENT

7-1. PURPOSE.

7-2. This section contains a list of documentation and lists support equipment for boilerplate 13.

7-3. DOCUMENTATION.

7-4. Table 7-1 is a list of documents containing supplementary information for boilerplate 13.

Table 7-1. Boilerplate 13 Supplementary Documents

Document No.	Title	Contents
SM1A-1	Support Manual Index	This manual contains a complete listing of Apollo support manuals.
SM2A-02	Spacecraft Familiarization Handbook	Description of spacecraft with all systems in overall terms.
SM2A-05-BP13	Transportation and Handling Procedures	Instructions for handling, packaging, packing shipping, transporting, and storing the Apollo spacecraft for boilerplate 13 and its associated ground support equipment.
SM3A-201	Transportation and Handling Equipment Maintenance Data Sheets	Maintenance procedures for transportation and handling equipment.
SM2A-01-1-BP13	Operation and Test Procedures for Assembly, Erection, System/Integrated Systems C/O (Downey Facility)	Detailed instructions for assembly, installation and checkout of boilerplate 13 at NAA/SID, Downey, California only.

Table 7-1. Boilerplate 13 Supplementary Documents (Cont)

Document No.	Title	Contents
SM3A-202	Auxiliary Checkout and Servicing Equipment Maintenance Data Sheets	Maintenance instructions covering inspection, cleaning, lubrication, trouble analysis, and maintenance of equipment.
SM3A-204	Signal Conditioner Console, Model C14-135, Part No. G16-552500-101	Physical and functional description and maintenance procedures consisting of functional tests and repair.
SM3A-205	Radar Transponder and Recovery Beacon Checkout Unit, Model C14-112, Part No. G16-852900	Physical and functional description and maintenance procedures consisting of functional tests and repair.
SM3A-208	Data Distribution and Recording Console, Model C14-420, Part No. G16-850500-101	Physical and functional description and maintenance procedures consisting of functional tests and repair.
SM3A-213	Antenna Checkout Group, Model C14-032, Part No. G16-850400-101	Physical and functional description and maintenance procedures consisting of functional tests and repair.
SM3A-221	Ground Cooling Cart, Model A14-011, Part No. J67000 (Model F-127)	Maintenance instructions covering inspection, cleaning, lubrication, trouble analysis, and maintenance of equipment.
SM3A-222	Launch Escape Tower Substitute Unit, Model A14-001, Part No. G16-820301-201	Physical and functional description and maintenance procedures consisting of functional tests and repair.
SM3A-226	Pyrotechnics Bench Maintenance Equipment, Model C14-051, Part No. G16-852700-101	Physical and functional description and maintenance procedures consisting of functional tests and repairs.

Table 7-1. Boilerplate 13 Supplementary Documents (Cont)

Document No.	Title	Contents
SM3A-227	Launch Escape Sequencer Bench Maintenance Equipment, Model No. C14-029, Part No. G16-853400-201	Physical and functional description of test, trouble analysis, repair, servicing, packaging, and diagrams as related to boilerplate 13 configuration.
SM3A-228	Launch Vehicle Subsitute Unit, Model A14-021, Part No. G16-821300	Physical and functional description and maintenance procedures consisting of functional tests and repair.
SM3A-229	Optical Alignment Set, Model A14-028, Part No. G17-824010	Physical and functional description and maintenance procedures consisting of functional tests and repair.
SM3A-235	Launch Control Group, Model C14-414, Part No. G16-853950-101	Physical and functional description and maintenance procedures consisting of functional tests and repair.
SM3A-244	Pyrotechnics Initiators Substitute Set, Model A14-003, Part No. G16-820500-201	Physical and functional description and maintenance procedures consisting of functional tests and repair.
SM3A-263	Water-Glycol Cooling Unit, Model S14-052, Part No. G16-848020	Maintenance instructions covering inspection, cleaning, lubrication, trouble analysis, and maintenance of equipment.
SM3A-272	MSFC Patch and Logic Distribution Sub Unit, Model A14-075, Part No. G16-853060	Physical and functional description and maintenance procedures consisting of functional tests and repair.

Table 7-1. Boilerplate 13 Supplementary Documents (Cont)

Document No.	Title	Contents
SM3A-273	Umbilical Junction Box, Model C14-192, Part No. G16-852850	Physical and functional description and maintenance procedures consisting of functional tests and repair.
SM4A-200-BP13	Maintenance Procedures BP13	Maintenance procedures, consisting of testing, trouble analysis, repair, removal and installation, and calibration and adjustment as related to boilerplate 13 configuration.

7-5. SUPPORTING EQUIPMENT.

7-6. The supporting equipment for boilerplate 13 is ground support equipment GSE listed in table 7-2. All listed GSE has been approved by NASA and has been shop-released.

Table 7-2. Ground Support Equipment

Model No.	Nomenclature	Part No.	Description
A14-001	Launch escape tower substitute unit	G16-820301-201	Provides electrical interface normally presented by LES to command module.
A14-003	Protechnics initiators substitute set	G16-820500-201	Substitutes for the protechnic initiators during systems check-out.
A14-009	Spacecraft adapter cover	G18-828001	A lightweight, synthetic, impregnated, fabric raincoat to protect adapter from sand, dust, rain, and salt spray.

Table 7-2. Ground Support Equipment (Cont)

Model No.	Nomenclature	Part No.	Description
A14-010	Command module cover	G16-828001	The cover is a lightweight, synthetic, impregnated, fabric raincoat, fitted to conform to the shape of command module. Used for protection against sand, dust, rain, and salt spray.
A14-011	Ground cooling cart	ME-362-0002-0001	The cart will filter, cool, dehumidify, or heat ambient air to a suitable level for introduction into interior of command module.
A14-020	Service module cover	G17-828003	The cover is a lightweight, synthetic, impregnated, fabric raincoat, fitted to conform to the shape of the service module. It is used to protect service module from sand, rain, and salt spray during handling, transportation and storage.
A14-021	Launch vehicle substitute unit C-1	G16-821300	Substitute for signals generated by the Saturn launch vehicle to the boilerplate. It also provides power to the Q-ball and monitors signals that may be returned from the Q-ball electronics

Table 7-2. Ground Support Equipment (Cont)

Model No.	Nomenclature	Part No.	Description
A14-022	Launch escape system cover	G15-828004-101	The cover is constructed from a lightweight, impregnated, fabric material and is fitted to conform to the shape of LES wherever possible. The cover consists of three sections which, when zipped together, form a weatherproof shield.
A14-024	Disconnect set, umbilical fluid and electrical	G16-828010-101	Interconnects GSE fluid and electrical lines with spacecraft umbilical panel. The disconnect set provides a method of automatically disengaging the fluid and electrical lines.
A14-026	Cap and plug set	G14-828012-301	Consists of covers, caps, and plugs for all electrical, hydraulic, and mechanical disconnects; duct, pipe, and interface openings; and areas to be protected from shipping and handling damage.
A14-027	Adapter cap and plug set	G14-828002	Consists of covers, caps, and plugs for all electrical, hydraulic, and mechanical disconnects; duct, pipe, and interface openings; and areas to be protected

Table 7-2. Ground Support Equipment (Cont)

Model No.	Nomenclature	Part No.	Description
A14-027 (cont)			from shipping and handling damage.
A14-028	Optical alignment set	G17-824010	The set is mounted on a mobile stand and has provisions for raising and lowering. The set is used to establish precise vertical planes for weight and balance operations.
A14-037	Adapter and duct set	G16-824200-101	Handles air from A14-011 ground cooling cart and conducts it through the open command module hatchway.
A14-046	Crane-control auxiliary	G14-820001	The unit has an upper eye which connects to crane hook and a lower eye which connects to load. This unit provides precise movement during raising and lowering operations.
A14-047	Box level	G14-820045	The level establishes the true vertical and horizontal planes used in conjunction with weight and balance fixtures to determine the center of gravity of launch escape system and spacecraft modules.

Table 7-2. Ground Support Equipment (Cont)

Model No.	Nomenclature	Part No.	Description
A14-076	Spacecraft GSE crossover distributor	G16-853056	Junction box for electrical cables.
A14-130	Wrench set, LES tower explosive bolt	G15-824080	The set consists of three special hexagon wrenches, a thread protector for the explosive bolt, and a container lined with foam rubber. The wrenches allow insertion into small openings in the LES tower leg.

Table 7-2. Ground Support Equipment (Cont)

Model No.	Nomenclature	Part No.	Description
C14-029	Launch escape sequencer bench maintenance equipment	G16-853400-201	The equipment will either assure proper operation of launch escape sequencer or help isolate any fault. The equipment is capable of checking either system in the sequencer, independently, or both systems simultaneously.
C14-032	Antenna checkout group	G16-850400-101	The unit is mounted on a cart and may be hand-pushed or transported by forklift. It is capable of verification of proper operation of the spacecraft antenna and associated transmission lines, power dividers, connectors, multiplexers and diplexers.
C14-112	C-band radar transponder checkout unit	G16-852900	A mobile unit mounted on rollers. It is used for operational checkout and adjustment of each C-band transponder in bench maintenance and in the spacecraft.
C14-135	Signal conditioner console	G16-852500-101	The console consists of a signal conditioner drawer, relay drawer, and panel terminal board. The signal conditioner will amplify very small

Table 7-2. Ground Support Equipment (Cont)

Model No.	Nomenclature	Part No.	Description
C14-135 (cont)			signals from the pressure and temperature transducers.
C14-135	Signal conditioner console	G16-852500-201	A mobile console mounted on rollers, consisting of a signal-conditioning drawer, relay drawer and panel terminal board. The unit interfaces with the data distribution and recording console C14-420. The signal conditioner is used to isolate GSE test circuits and provide signal amplification of pressure and temperature transducers.
C14-177	Electrical cable set AMR	G16-852800	The cable set consists of approximately 38 cables, of lengths which vary from 31 to 93 feet approximately. The cable set is used to transfer electrical power, monitor signals, and control signals between spacecraft and associated GSE during checkout and test program.

Table 7-2. Ground Support Equipment (Cont)

Model No.	Nomenclature	Part No.	Description
C14-180	Electrical cable set	G16-853450	The cable set consists of approximately 38 cables of lengths which vary from 31 to 93 feet. The cable set is used to transfer electrical power, monitor signals, and control signals between spacecraft and associated GSE during checkout and test program.
C14-186	Electrical cable set	G16-850065	The set consists of 50 cables, the lengths varying from 6 to 70 feet. The cables are used to transfer electrical power, monitor and control signals to and from spacecraft and ground support equipment.
C14-191	Electrical terminal distributor	G16-851300	Cabinet mounted to floor in test area, providing connection points between the spacecraft and various GSE units. Cabinet contains fuses, terminal blocks, and a power distribution panel with circuit breakers.
C14-192	Umbilical junction box	G16-852850	The junction box is approximately 60 inches high, 48 inches wide, and 12 inches deep. The box is constructed of stainless sheet steel

Table 7-2. Ground Support Equipment (Cont)

Model No.	Nomenclature	Part No.	Description
C14-192 (Cont)			and contains approximately 40 terminal blocks capable of handling 740 wires. The junction box is used to make electrical interconnections between the spacecraft and ground support equipment.
C14-414	Launch control group	G16-953950-101	Group consists of five system panels on drawer assemblies mounted in a five-bay equipment rack. The panels are: test conductor panel, electrical power system panel, instrumentation and communication systems panel, environmental control system panel, and launch escape system panel.
C14-420	Data distribution and recording console	G16-850500-101	The console provides a means of integrating data signals from the spacecraft, Marshall Space Flight Control Panel (MSFC), and the NAA ground support equipment panels. The system also provides monitoring and/or recording capability for all signals routed through console.

Table 7-2. Ground Support Equipment (Cont)

Model No.	Nomenclature	Part No.	Description
H14-011	Launch escape alignment stand	G15-810042	The stand consists of two rails mounted on four adjustable legs. The rails are 48 inches apart and will attach to the ends of rail system of H14-052.
H14-016	Launch escape system weight and balance fixture	G15-810029	Fixture consists of two welded square-tubing structures bolted together and supported by short jacks. The upper surface of the frame has six level mounting pads for mounting load cells and a laterally and vertically adjustable cradle to support and position LES components.
H14-017	Spacecraft weight and balance fixture	G14-810007	The fixture is constructed of aluminum tubing which forms a support ring for the service module. Adjustable pads are provided on ring to match fittings on aft end of command module.
H14-018	Escape tower support	G15-810026	Welded tubular structure equipped with four clamps to secure the tower and four roller assemblies to rails of H14-011 alignment stand and H14-052 positioning trailer.

Table 7-2. Ground Support Equipment (Cont)

Model No.	Nomenclature	Part No.	Description
H14-021	Ground support equipment handling cart	G14-810050	Can be used to transport light-weight miscellaneous components, such as load cell kits and removable pieces from equipment, tools, etc.
H14-027	Adapter, rail transfer, skirt	G15-810051	The rail adapter is a low-carbon steel, tubular, welded assembly which supports model H14-029, skirt sling. The adapter provides all necessary adjustments for mounting skirt on launch escape motor.
H14-029	Sling, flow skirt	G15-810058	The sling is a low-carbon steel tube, welded circular ring with four drilled lugs. The ring is attached to the structural skirt by bolting to the matching holes on the skirt.
H14-042	Hoist beam, service module and spacecraft adapter	G17-818108	The hoist beam is structural steel formed into a X-shape with attach points at the end of each leg. Four cables attach to the hoist beam and join at a common lifting eye at the other end. The hoist beam is used to hoist, handle, rotate, position for weight and balance, and provide tie-down

Table 7-2. Ground Support Equipment (Cont)

Model No.	Nomenclature	Part No.	Description
			during transportation of the service module or spacecraft adapter.
H14-043	Sling, jettison motor	G15-810002-101	The sling consists of a wire-rope calbe with an attachment fitting at either end. A lifting eye in center of cable is provided for a crane hook. Removal of four screws from the jettison motor assembly provides hole patterns for attachment of this sling.
H14-052	Positioning trailer, narrow base.	G16-810150	The trailer has two rails that are 48 inches apart. A combination of hydraulic and mechanical actuators provide pitch, roll, yaw, and vertical lift to the two rails.
H14-054	Jettison motor support	G15-810027	The support consists of two rings which attach near either end of jettison motor. The motor can be rotated or moved longitudinally when rings engage rollers on the H14-011 workstand. The motor support is used during assembly of the pitch or launch motors to the jettison motor.

Table 7-2. Ground Support Equipment (Cont)

Model No.	Nomenclature	Part No.	Description
H14-055	Launch escape motor support	G15-810028	The support consists of two rings which attach to launch escape motor. The motor can be rotated or moved longitudinally when installed on H14-011 workstand.
H14-057	Forward compartment shield sling	G16-810040-101	The sling consists of four cable assemblies terminating at one end in a lift eye and attaching to four identical swaged clevis fittings at the other end. The swaged fittings are pinned to other fittings which attach to the forward compartment heat shield.
H14-084	Adapter, rollover	G15-810060-101	The adapter is a rigid, self-contained base mounted on rollers. The adapter is designed to attach to base of launch escape system tower legs and provides the pivoting motion required to position LES from the horizontal to the vertical plane.
H14-091	Stand, access, command module hatch	G16-810075	The stand is an erector-type scaffold, supporting a railed platform with stairs extending to ground level. A pair of removable, tubular supports are provided

Table 7-2. Ground Support Equipment (Cont)

Model No.	Nomenclature	Part No.	Description
H14-091 (Cont)			for mounting the A14-036 circulating blower.
H14-092	Sling, pitch control, motor interstage structure	G14-810036	The sling consists of a lifting ring, interface connecting brackets, and a cantilevered arm for hoisting interstage structure.
H14-093	Boatswain's chair	G16-810087-101	The chair is designed to support a man in a sitting position, and provides freedom of movement to gain access to areas beyond reach of access stands. The chair can be lifted vertically by utilizing facility crane or similar means.
H14-094	Sling, jettison motor, pitch control motor and nose cone	G14-810037	The sling consists of a beam approximately 41 inches long with a hook at either end and a lifting ring in the center. Two sling bands are provided to fit around motor combination for hoisting.
H14-096	Hook, ballast pickup, launch escape system	G14-810039	The hoisting device is L-shaped with an indexing pin for ballast on one end and a lifting eye on the other end.

Table 7-2. Ground Support Equipment (Cont)

Model No.	Nomenclature	Part No.	Description
H14-097	Stand, access launch escape system build-up	G15-810150	The stand is a pipe-constructed frame-work covered with a 4 x 7 foot platform. The stand is mounted on four casters and may be manually operated through a 3- to 7-foot height range by a hydraulic cylinder.
H14-099	Wrench, pitch control motor LES	G15-810050	The special tool is a socket-type wrench for tightening pitch control motor mount-ing nut V14-300412.
H14-109	Access stand, service module (external)	G17-810070	The access stand is constructed of light tubular scaffoldings that forms a rigid structure around the service module. A square platform, with a circular cutout to clear the service module, is installed at the 20-foot level. A lightweight plastic cover, an air condi-tioning system, and incandescent lighting is also provided.
H14-111	Access ladder, command module hatch	G16-810162	A stepladder that may be positioned on H14-109 workstand platform and allowed to rest against command module for entrance to hatch.

Table 7-2. Ground Support Equipment (Cont)

Model No.	Nomenclature	Part No.	Description
H14-126	Beam, weight and balance, service module and adapter	G17-810200	The beam is approximately 155 inches long with a lifting eye in the center and attaching fittings at the ends. The beam will attach to either end of adapter and to the lower end of service module for weight and balance operation.
H14-127	Cable and fitting set, weight and balance, service module adapter	G17-810220	The fitting set consists of conical-shaped buttons with a shank for installation into aft interface of spacecraft adapter and/or extension. The set is used during weight and balance operations.
H14-131	Spacecraft vertical transport vehicle	ME-183-0024-0001	The vehicle is a large, tandem-axle semi-trailer used to transport the boilerplate spacecraft minus the launch escape system.
H14-139	Forward compartment heat shield retention bolt guide	G16-810245	The bolt guide is tapered, and screws over the retention bolts for thread protection and acts as a guide during installation.

Table 7-2. Ground Support Equipment (Cont)

Model No.	Nomenclature	Part No.	Description
H14-140	Cartridge, test chamber	G16-810250	The test chamber is a metal, cylindrical-shaped assembly. It provides a safe means of checking gas generator cartridges and initiators of the earth landing system, launch escape system, and forward heat shield separation system.
H14-154	DC Digital Indicator	G14-890002	
H14-9001	Sling assembly - command module test vehicle	G16-810004	The sling set consists of three cable assemblies terminating in a common lift eye at one end and bolting into three bracket assemblies at the other end. These bracket assemblies in turn attach to brackets on the sides of the boilerplate command module.
H14-9006	Sling set, weight and balance	G16-810010-101	The sling set consists of two cable assemblies terminating in a lift eye at one end and attaching to a pair of trunnion fittings on the other end. These fittings are bolted to the sides of the command module to hoist, and/or rotate it for establishing precise center of gravity in all three planes.

Table 7-2. Ground Support Equipment (Cont)

Model No.	Nomenclature	Part No.	Description
H14-9015	Jack set, weight and balance	G16-810012-101	The jack set consists of three jacks, pads and a fitting. The set is used to support and level the command module, service module or adapter for determining weight and center of gravity measurements.
H14-9073	Spacecraft boilerplate sling	G14-810001	The slings consists of three cable assemblies terminating at one end in a lift eye and swaged fittings at the other end attached to a tee-shaped structure with a collapsible arm. Adjustable turnbuckles extend from this structure and bolt to attach fittings which in turn fasten to the spacecraft. The sling attaches to the command module at the LES attach points.
H14-9076	General purpose dolly	G16-810033-101	Consists of a welded, rectangular steel frame, four lateral support brackets, and necessary tie-down brackets. Unit has lockable casters bolted to each corner of frame and a

Table 7-2. Ground Support Equipment (Cont)

Model No.	Nomenclature	Part No.	Description
			removable tow bar assembly with swivel-type brackets in front and back of frame.
H14-9077	Sling, access door, service module	G17-810001	The sling consists of a single cable with swaged fittings at each end. A spreader bar is positioned to prevent excessive compression loading of the panels that are hoisted. The sling is used for panels on service module, insert, and adapter.
S14-015	Battery charging unit	G14-840100-101	The unit has a d-c voltmeter, d-c ammeter, and a circuit breaker for a-c line protection. The charging unit is used to charge the spacecraft batteries.
S14-034	Fluid distribution system	G14-848018	The system consists of tubing, flex hoses, relief valves, and necessary supports etc., required to route and secure the tubing between GSE and spacecraft. Used during checkout at Downey, California.

Table 7-2. Ground Support Equipment (Cont)

Model No.	Nomenclature	Part No.	Description
S14-036	Fluid distribution system	G14-848018	The system consists of tubing, flex hoses, relief valves and necessary supports etc., required to connect GSE for servicing and check-out of spacecraft fluid system.
S14-052	Water-glycol, cooling unit	G16-848020-101	The unit is contained in a steel enclosure and mounted on skids. It is used to fill and circulate water-glycol solution through the environmental control system at controlled temperatures.

SECTION VIII

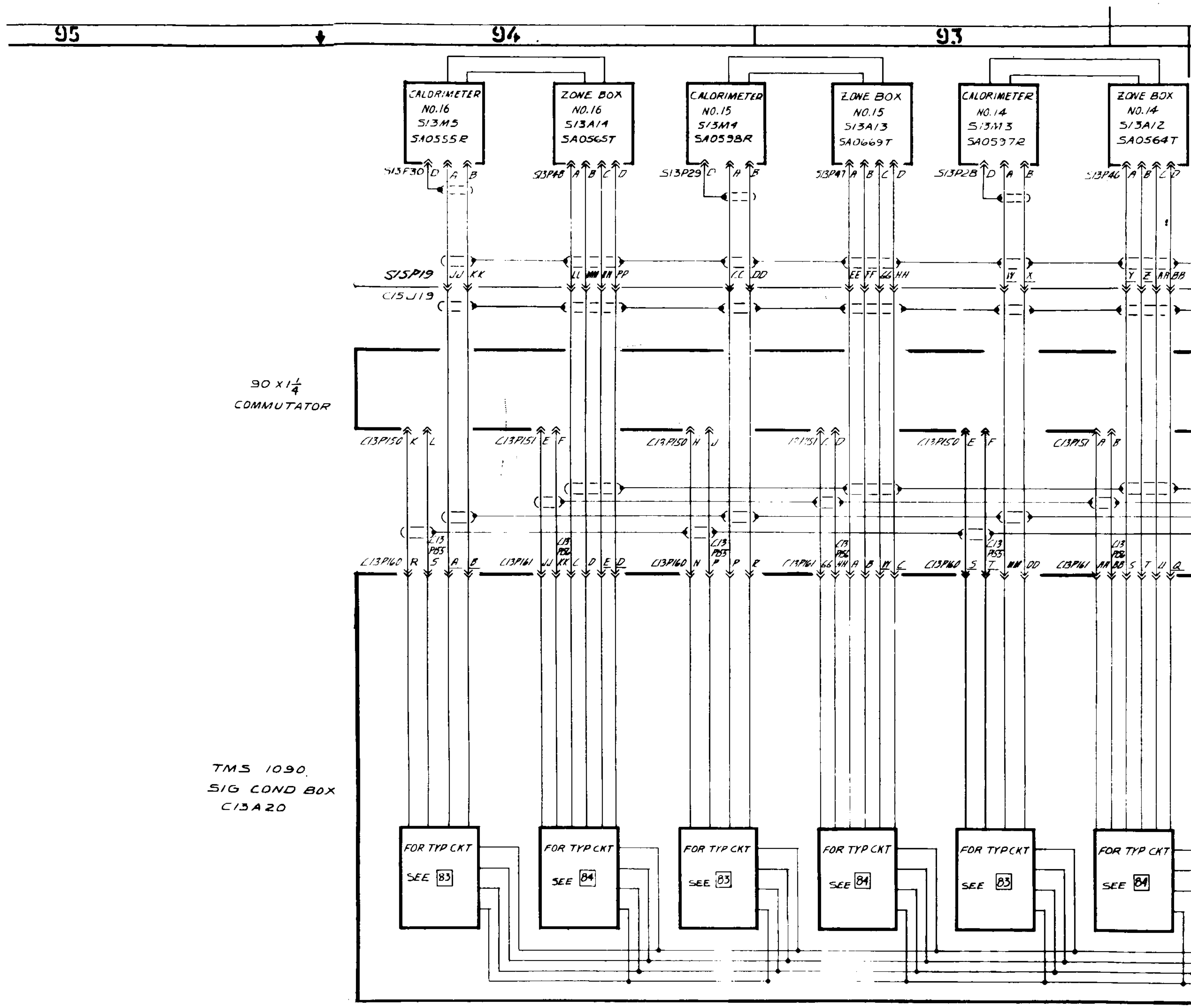
ELECTRICAL SCHEMATICS

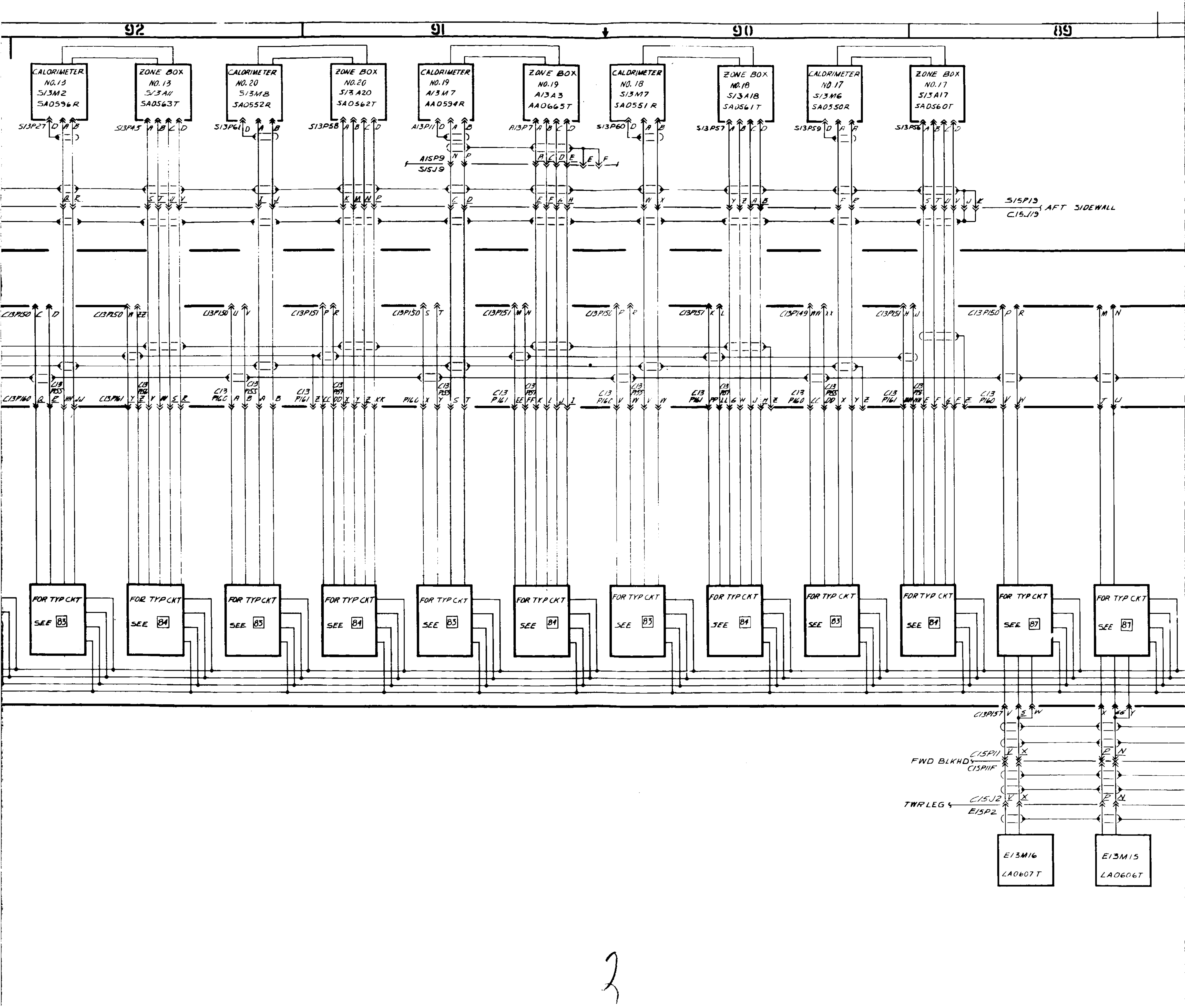
8-1. PURPOSE.

8-2. This section contains the electrical wiring schematics for boilerplate 13. (See figures 8-1 and 8-2.)

8-3. SCHEMATIC DIAGRAMS.

8-4. The combined systems schematic diagram for boilerplate 13 is shown in figure 8-1, and the combined systems schematic for the associated ground support equipment is shown in figure 8-2. The bottom edge of the GSE schematic is made to match the top edge of the boilerplate 13 schematic; therefore, by matching zone numbers at the bottom of figure 8-2 with zone numbers at the top of figure 8-1, the circuitry from GSE to the boilerplate can be easily traced. The GSE combined systems schematics in figure 8-2 are for use during checkout in the hangar area only. Electrical schematics for checkout on the launch pad will be included in the next revision.


95
94
93
CALORIMETER NO.16 S13M5 SA0555R
ZONE BOX NO.16 S13A14 SA0565T
CALORIMETER NO.15 S13M4 SA0598R
ZONE BOX NO.15 S13A13 SA0669T
CALORIMETER NO.14 S13M3 SA0597R
ZONE BOX NO.14 S13A12 SA0564T
S15P19
C15J19
90 X 1 1/4
COMMUTATOR
TMS 1090
SIG COND BOX
C13A20
FOR TYP CKT SEE 83
FOR TYP CKT SEE 84
FOR TYP CKT SEE 83
FOR TYP CKT SEE 84
FOR TYP CKT SEE 83
FOR TYP CKT SEE 84



92
91
90
89
CALORIMETER NO.13 S13M2 SA0596R
ZONE BOX NO.13 S13A11 SA0563T
CALORIMETER NO.20 S13M8 SA0552R
ZONE BOX NO.20 S13A20 SA0562T
CALORIMETER NO.19 A13M7 AA0594R
ZONE BOX NO.19 A13A3 AA0665T
CALORIMETER NO.18 S13M7 SA0551R
ZONE BOX NO.18 S13A18 SA0561T
CALORIMETER NO.17 S13M6 SA0550R
ZONE BOX NO.17 S13A17 SA0560T
A15P9
S15J9
S15P19
C15J19
AFT SIDEWALL
FOR TYP CKT SEE 83
FOR TYP CKT SEE 84
FOR TYP CKT SEE 87
C13P157
FWD BLKHD
C15P11
C15P11F
TWR LEG
C15J2
E15P2
E13M16 LA0607T
E13M15 LA0606T
2

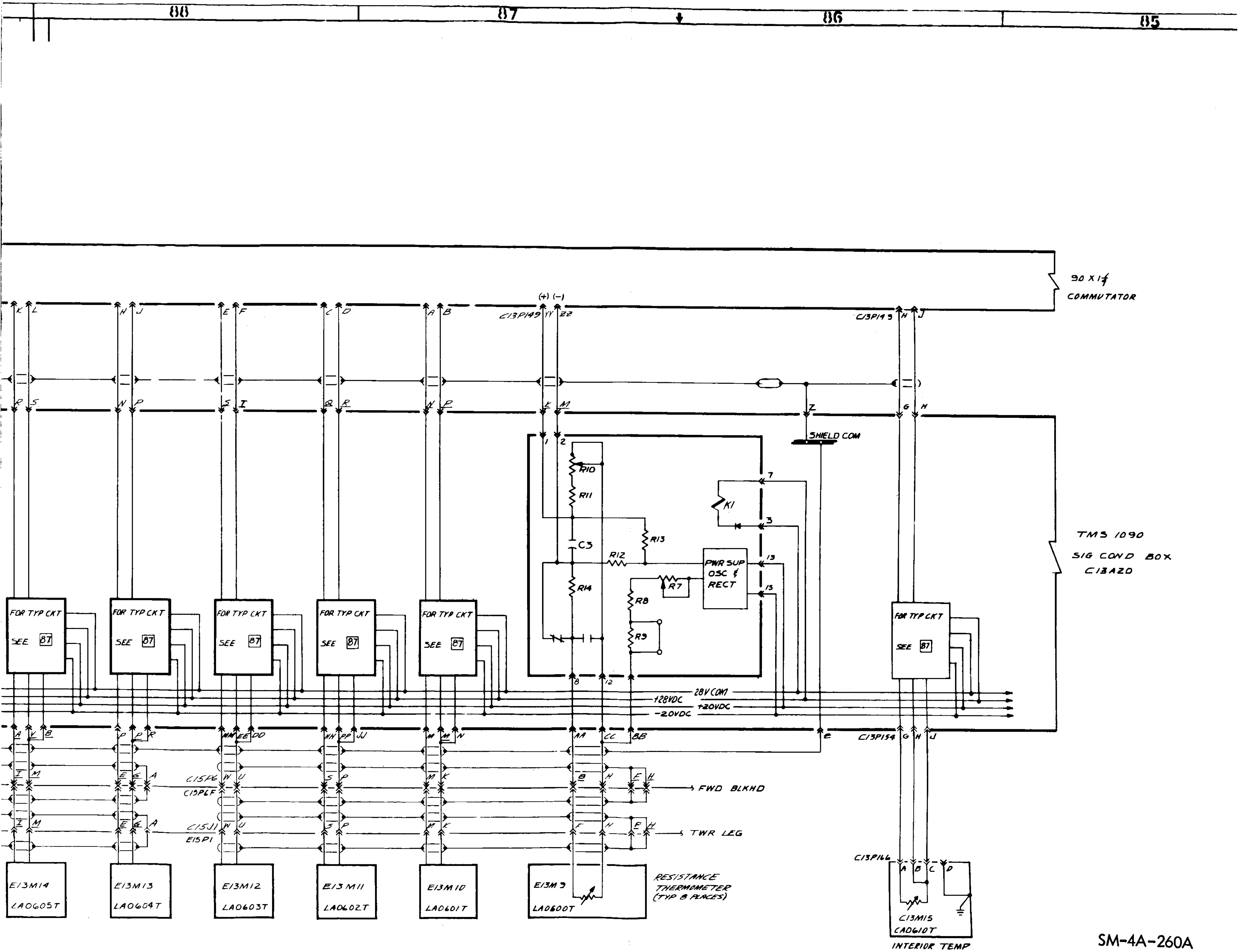
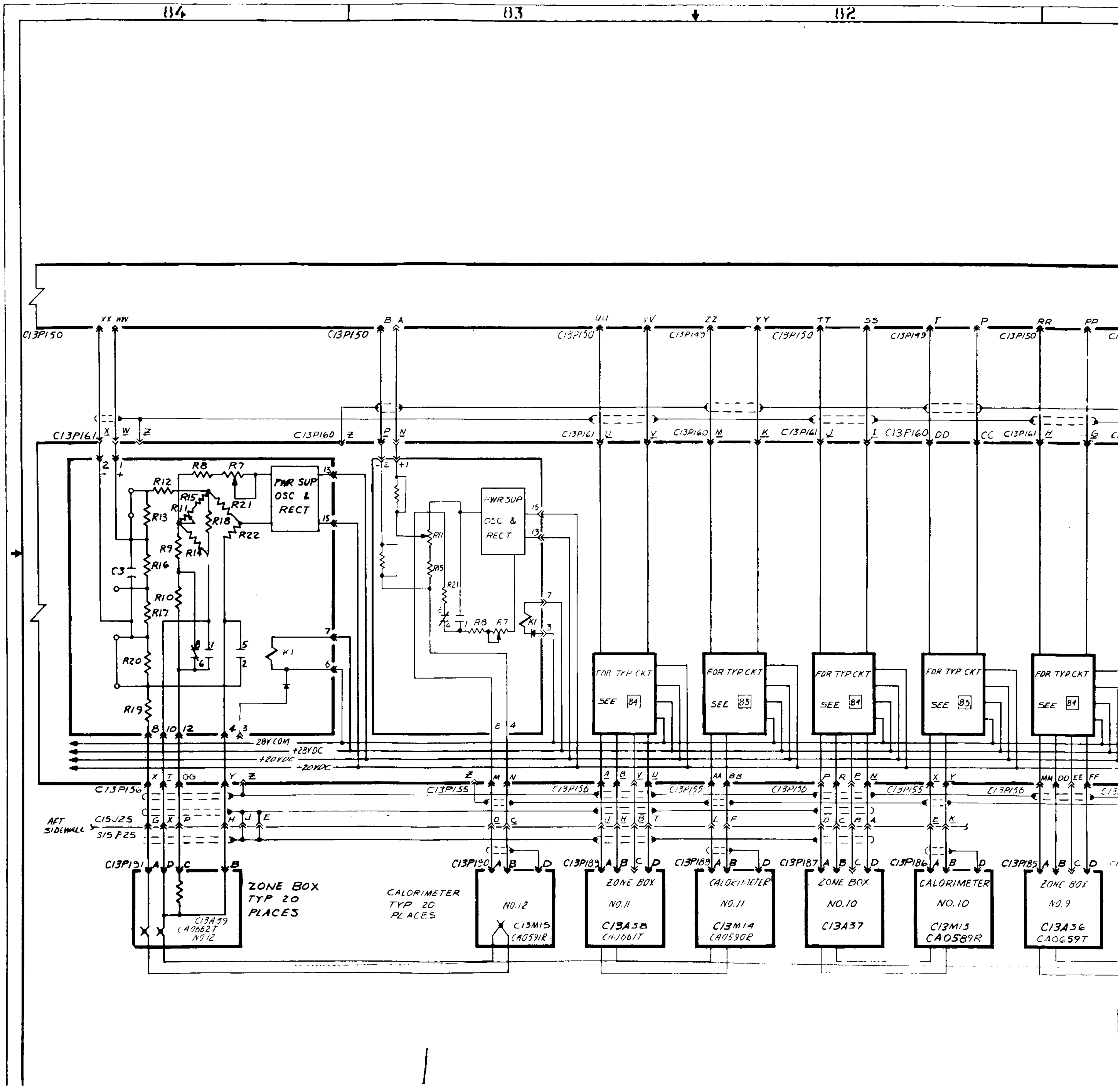


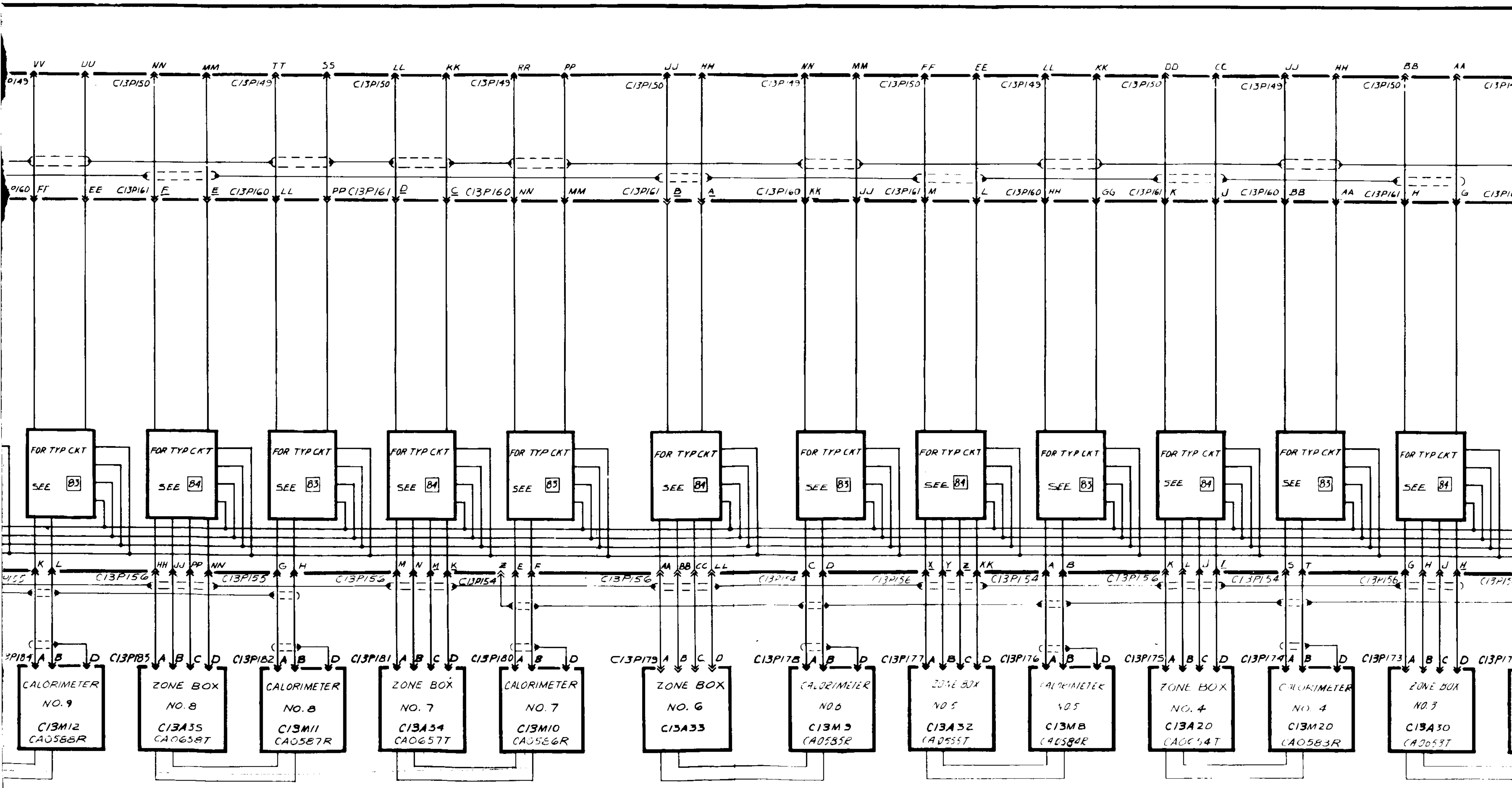
Figure 8-1. Boilerplate 13 Combined Systems Schematic
(Dwg B14-90004, Chg A) (Sheet 1 of 8)

3



84
83
82
C13P150
C13P149
C13P161
C13P160
PWR SUP OSC & RECT
K1
28V COM
+28VDC
+20VDC
-20VDC
C13P156
C13P155
AFT SIDEWALL
C15J25
S15P25
C13P191
C13P190
C13P189
C13P188
C13P187
C13P186
C13P185
ZONE BOX TYP 20 PLACES
C13A39 CA0662T NO 12
CALORIMETER TYP 20 PLACES
NO.12
C13M15 CA0591R
ZONE BOX NO.11 C13A38 CA0661T
CALORIMETER NO.11 C13M14 CA0590R
ZONE BOX NO.10 C13A37
CALORIMETER NO.10 C13M13 CA0589R
ZONE BOX NO.9 C13A36 CA0659T
FOR TYP CKT SEE 84
FOR TYP CKT SEE 83

81 80 79 78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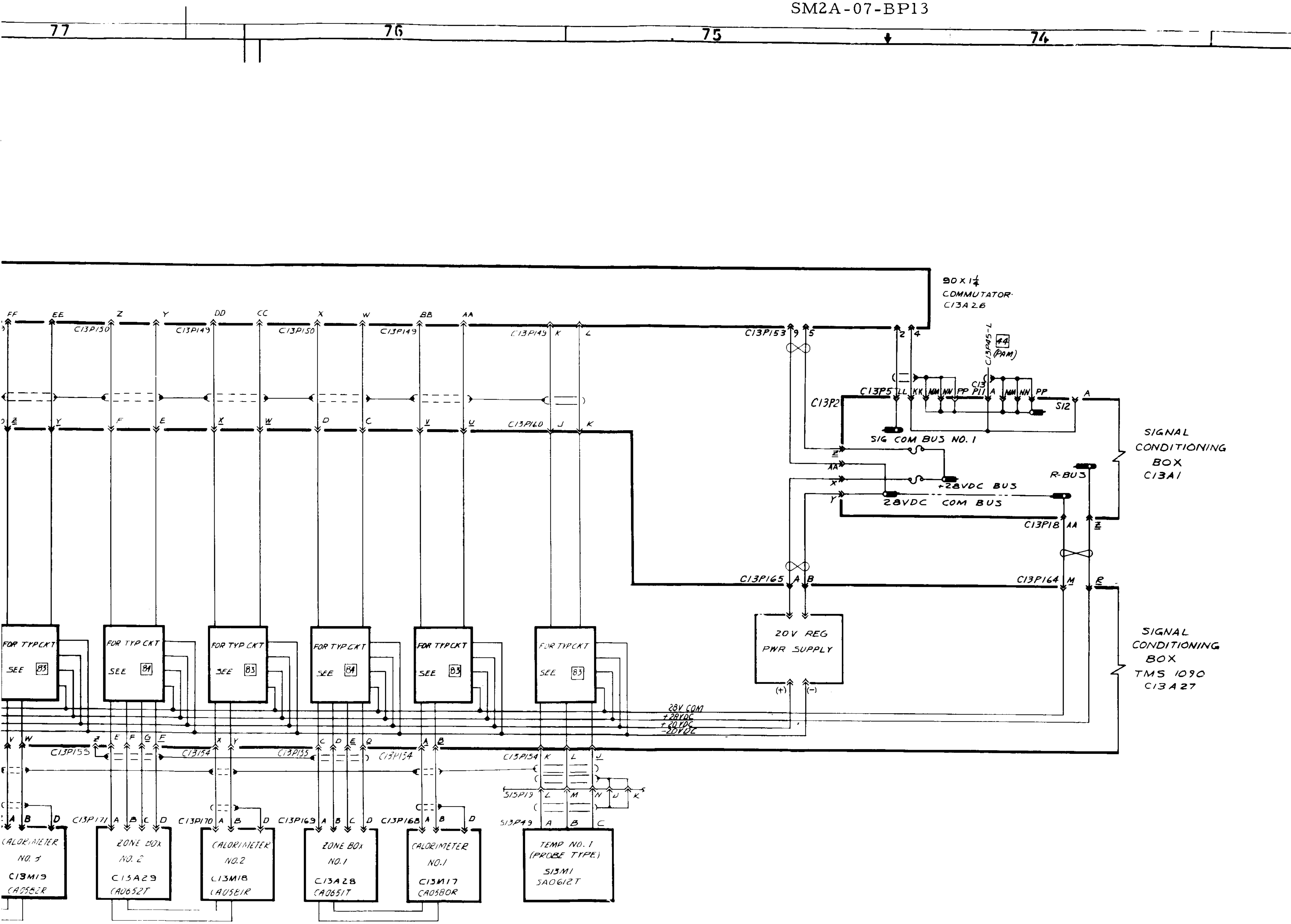
ZONE BOX NO. 8 C13A35 CA0658T
CALORIMETER NO. 8 C13M11 CA0587R
ZONE BOX NO. 7 C13A34 CA0657T
CALORIMETER NO. 7 C13M10 CA0586R
ZONE BOX NO. 6 C13A33
CALORIMETER NO. 6 C13M9 CA0585R
ZONE BOX NO. 5 C13A32 CA0555T
CALORIMETER NO. 5 C13M8 CA0584R
ZONE BOX NO. 4 C13A20 CA0654T
CALORIMETER NO. 4 C13M20 CA0583R
ZONE BOX NO. 3 C13A30 CA0653T
FOR TYP CKT SEE 83
FOR TYP CKT SEE 84
C13P149
C13P150
C13P160
C13P161
C13P154
C13P155
C13P156
C13P173
C13P174
C13P175
C13P176
C13P177
C13P178
C13P179
C13P180
C13P181
C13P182
C13P183
C13P184

2



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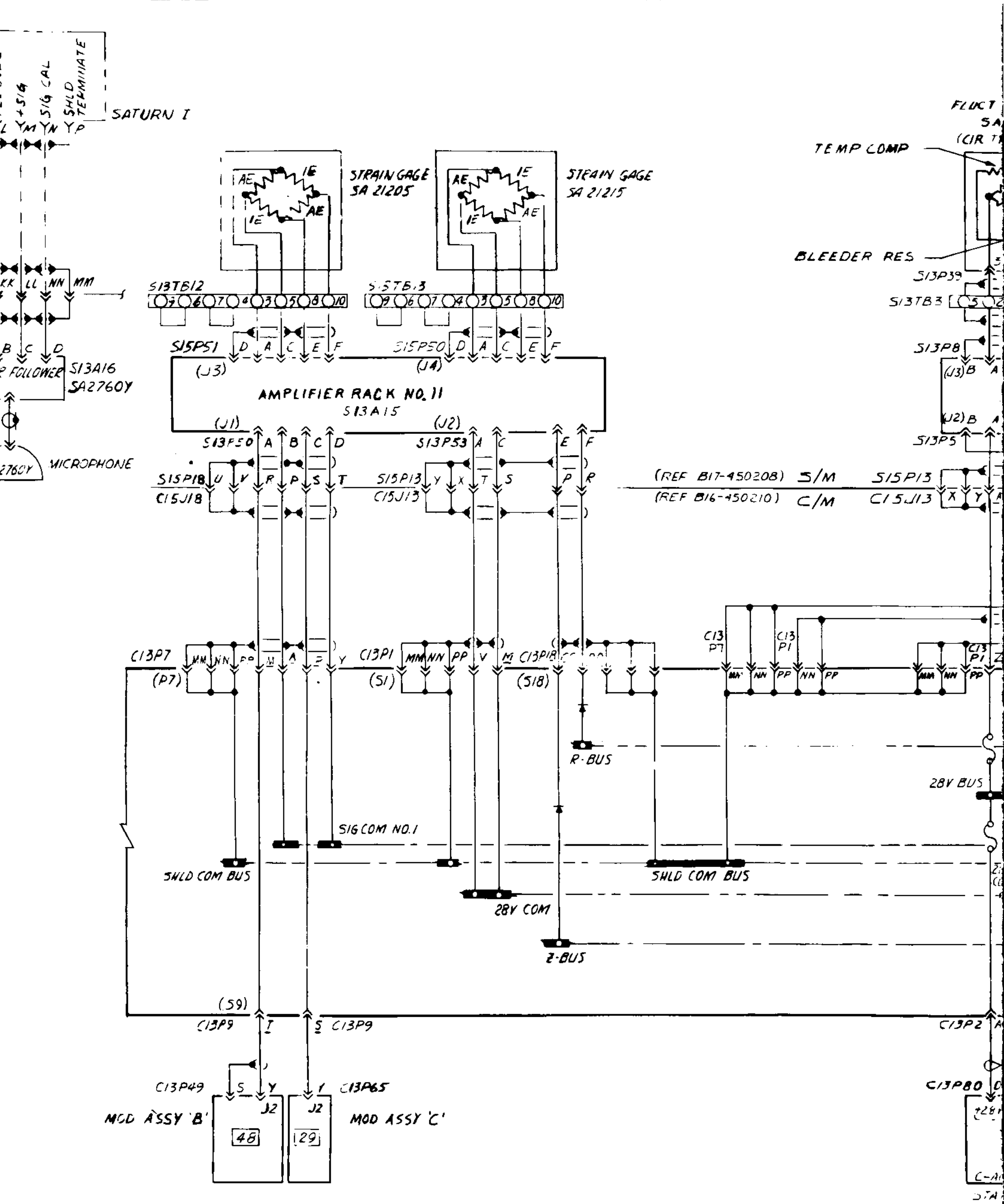
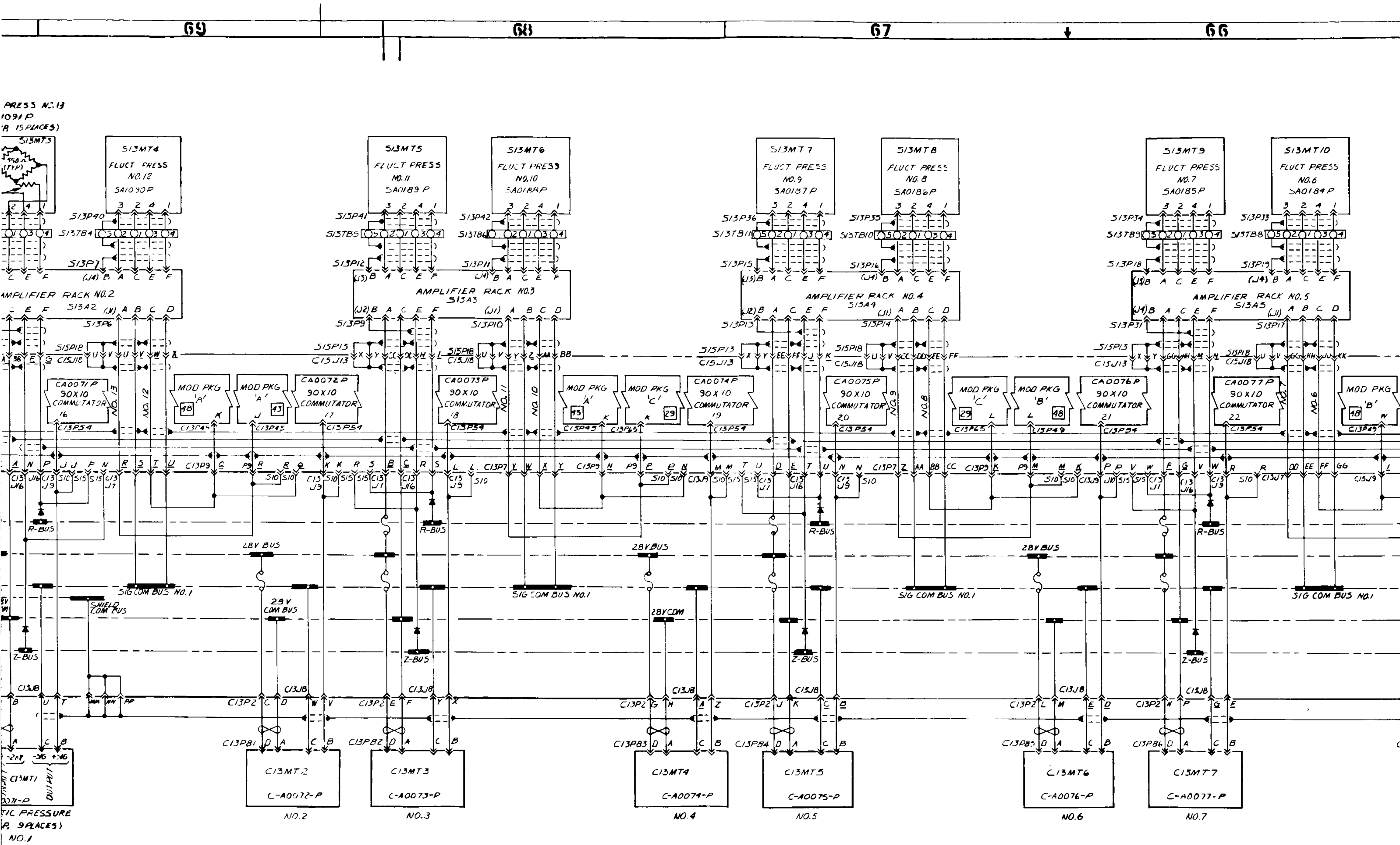
3

Figure 8-1. Boilerplate 13 Combined Systems Schematic (Dwg B14-90004, Chg A) (Sheet 2 of 8)


SATURN I
VIBRATION ACCELEROMETER 6AC0390
VIBRATION ACCELEROMETER AF09900
STRAIN GAGE SA 21205
STRAIN GAGE SA 21215
AMPLIFIER RACK NO. 11
S13A15
EMITTER FOLLOWER
S13A16
SA2760Y
MICROPHONE
(REF B17-450208) S/M
(REF B16-450210) C/M
TEMP COMP
BLEEDER RES
R-BUS
28V BUS
SIG COM NO.1
SHLD COM BUS
28V COM
Z-BUS
MOD ASSY 'B'
MOD ASSY 'C'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68
67
66
S13MT4
FLUCT PRESS
NO.12
SA1090P
S13MT5
FLUCT PRESS
NO.11
SA0189 P
S13MT6
FLUCT PRESS
NO.10
SA0188P
S13MT7
FLUCT PRESS
NO.9
SA0187 P
S13MT8
FLUCT PRESS
NO.8
SA0186P
S13MT9
FLUCT PRESS
NO.7
SA0185P
S13MT10
FLUCT PRESS
NO.6
SA0184 P
AMPLIFIER RACK NO.2
S13A2
AMPLIFIER RACK NO.3
S13A3
AMPLIFIER RACK NO.4
S13A4
AMPLIFIER RACK NO.5
S13A5
CA0071 P
90X10
COMMUTATOR
16
CA0072 P
90X10
COMMUTATOR
17
CA0073P
90X10
COMMUTATOR
18
CA0074 P
90 X 10
COMMUTATOR
19
CA0075P
90X10
COMMUTATOR
20
CA0076 P
90X10
COMMUTATOR
21
CA0077 P
90X10
COMMUTATOR
22
MOD PKG
R-BUS
Z-BUS
28V BUS
28V COM BUS
SIG COM BUS NO.1
SHIELD COM BUS
C13MT1
C13MT2
C-A0072-P
NO.2
C13MT3
C-A0073-P
NO.3
C13MT4
C-A0074-P
NO.4
C13MT5
C-A0075-P
NO.5
C13MT6
C-A0076-P
NO.6
C13MT7
C-A0077-P
NO.7

2

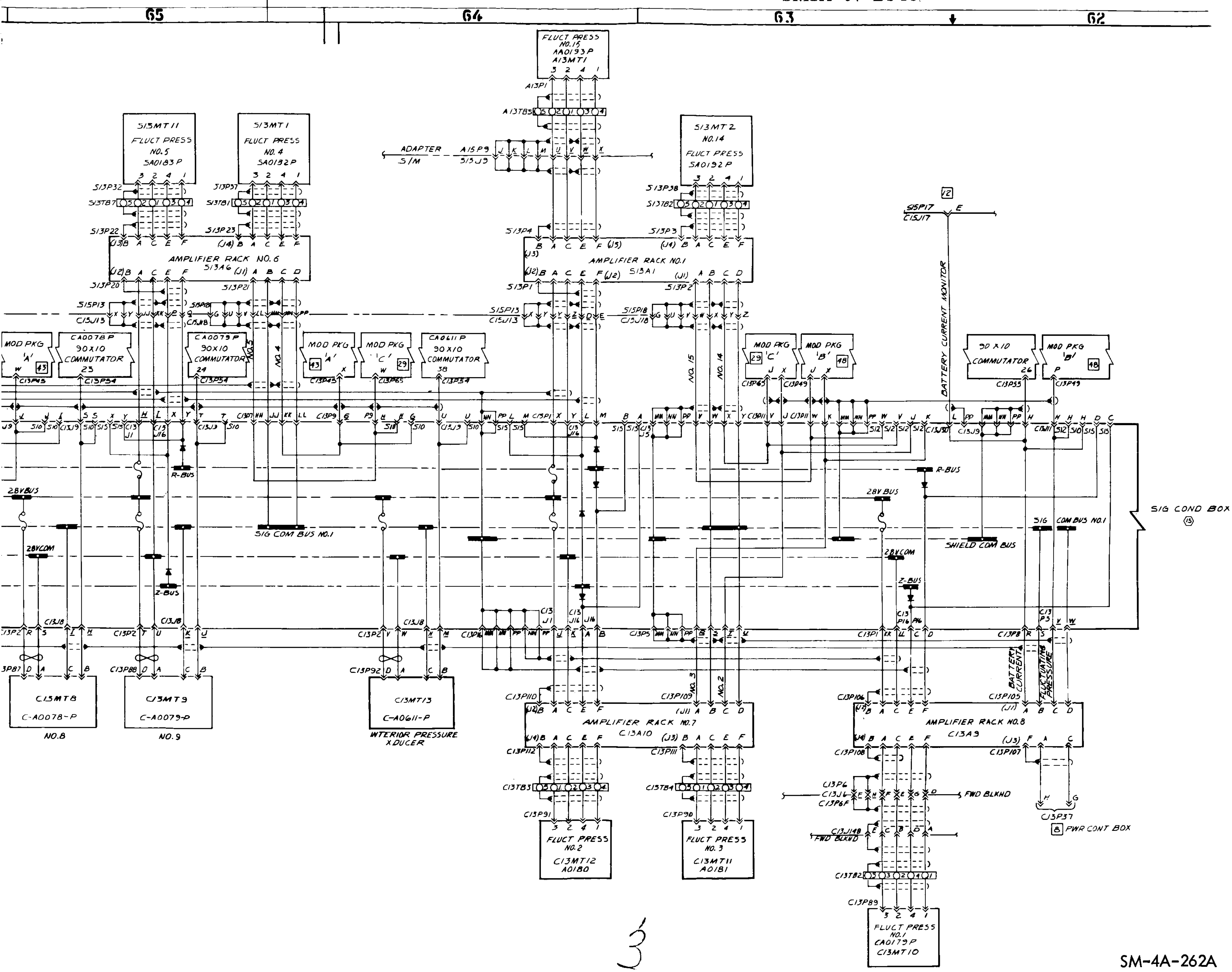

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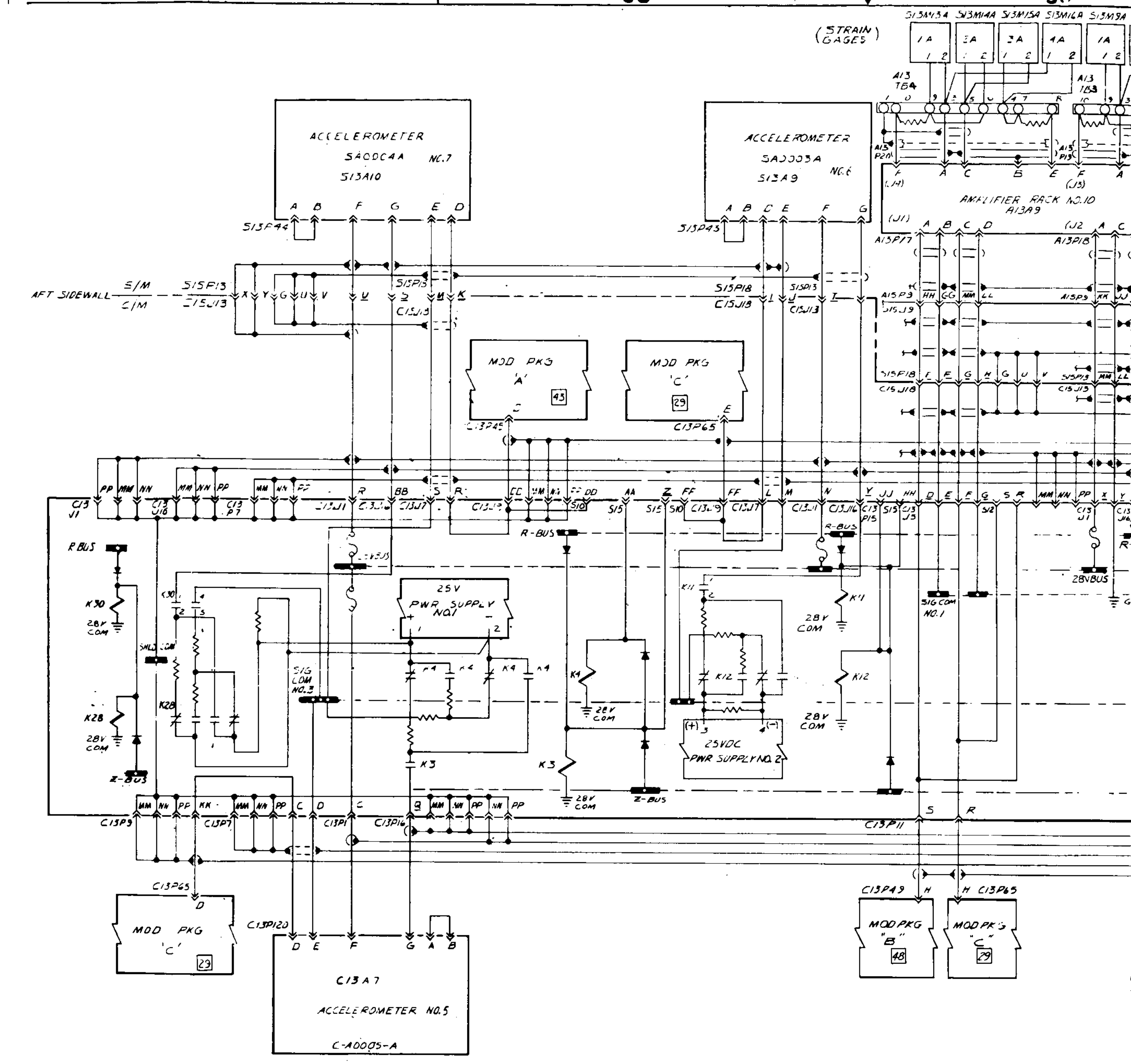
Figure 8-1. Boilerplate 13 Combined Systems Schematic (Dwg B14-90004, Chg A) (Sheet 3 of 8)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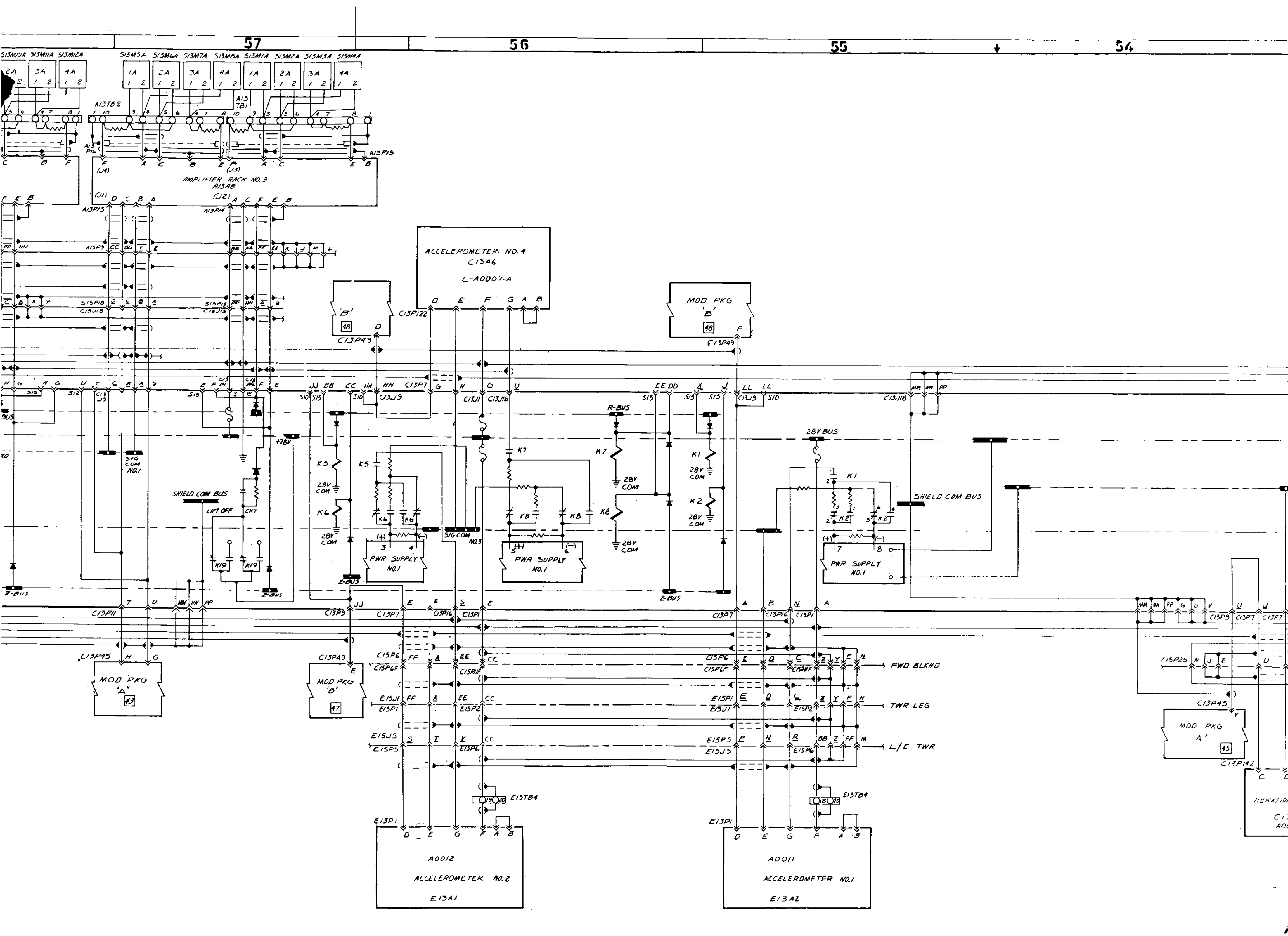
ACCELEROMETER SA0003A NO.6 S13A9
AMPLIFIER RACK NO.10 A13A9
AFT SIDEWALL S/M C/M
MOD PKG 'A' 43
MOD PKG 'C' 29
25V PWR SUPPLY NO.1
25VDC PWR SUPPLY NO.2
R BUS
Z-BUS
28V COM
SIG COM NO.1
SIG COM NO.3
28VBUS
MOD PKG 'C' 29
C13A7 ACCELEROMETER NO.5 C-A0005-A
MOD PKG "B" 48
MOD PKG "C" 29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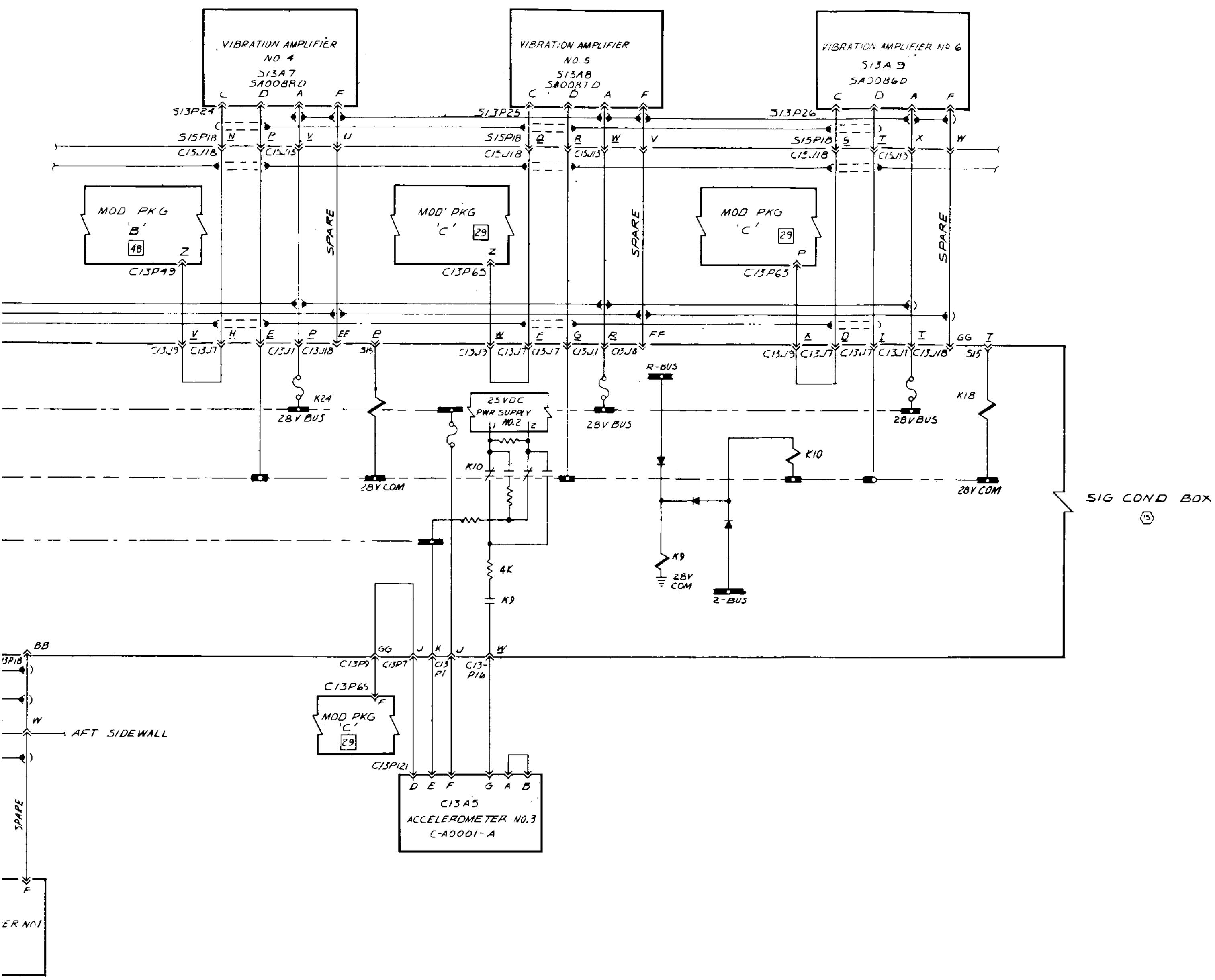
AMPLIFIER RACK NO. 9
A13A8
ACCELEROMETER NO. 4
C13A6
C-A0007-A
MOD PKG
'B'
48
SHIELD COM BUS
28V BUS
R-BUS
Z-BUS
SIG COM
PWR SUPPLY
NO. 1
LIFT OFF
CKT
MOD PKG
'A'
43
MOD PKG
'B'
47
FWD BLKHD
TWR LEG
L/E TWR
E13TB4
A0012
ACCELEROMETER NO. 2
E13A1
A0011
ACCELEROMETER NO. 1
E13A2
MOD PKG
'A'
45

2

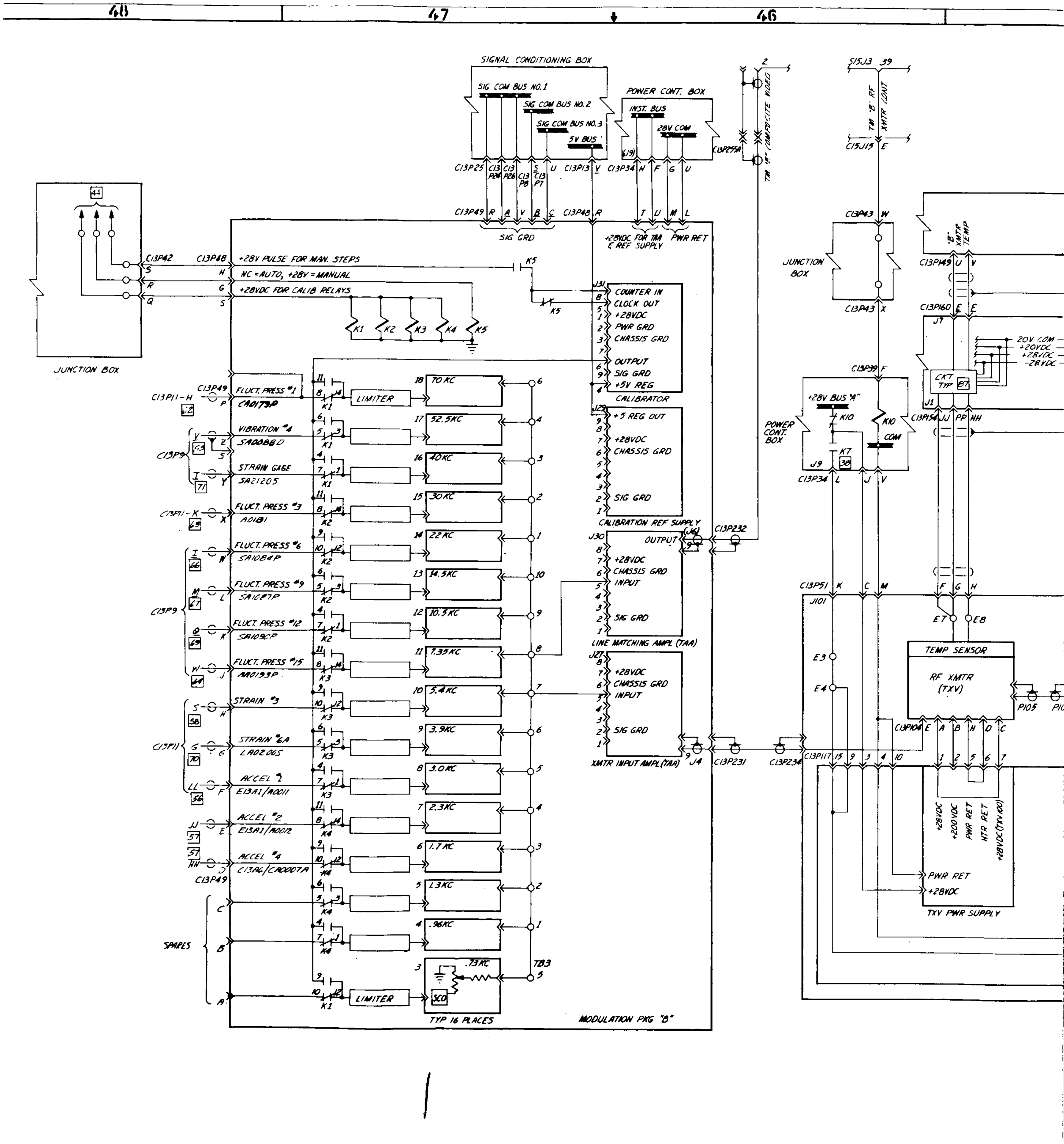
53 52 51 50

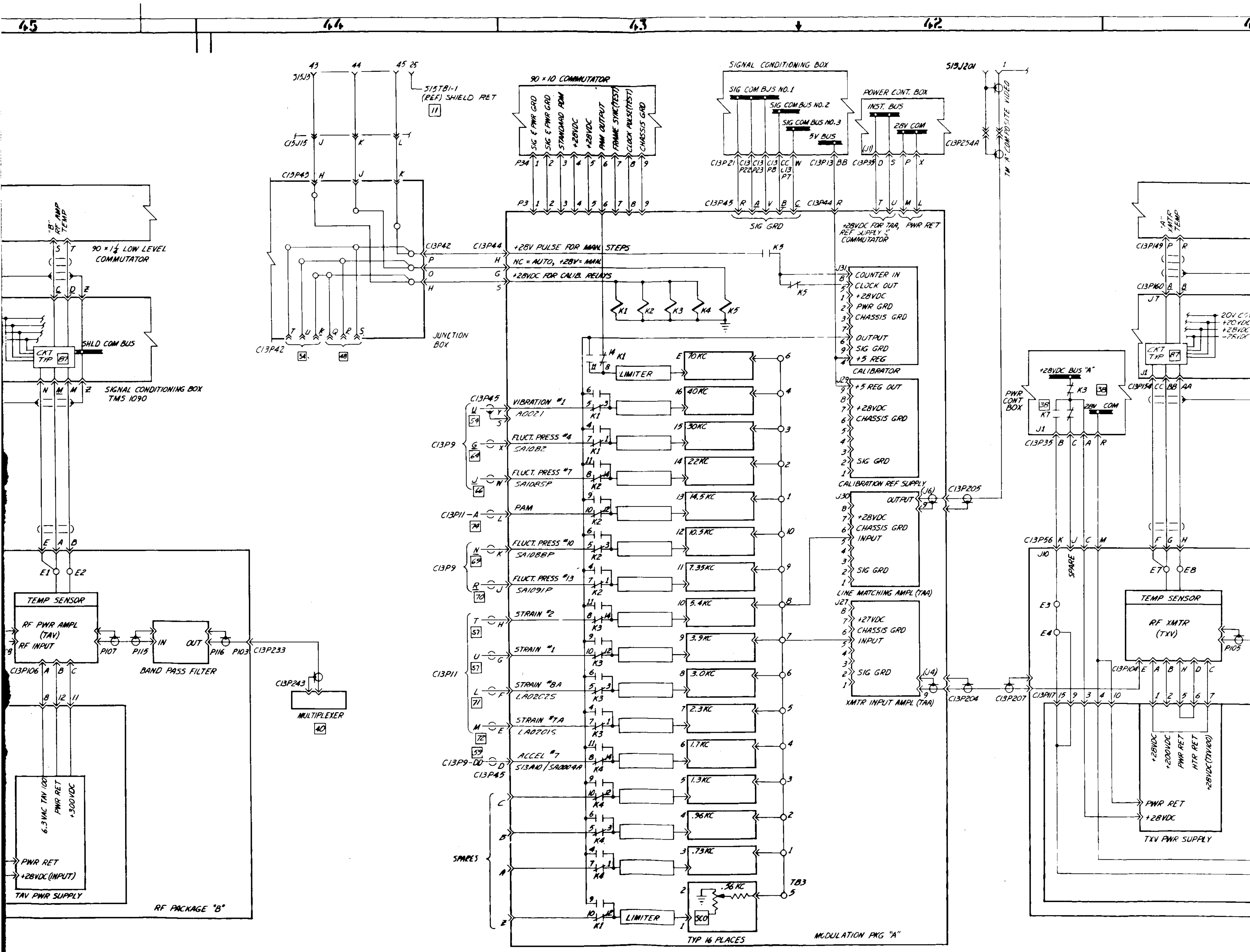


3

SM-4A-263B

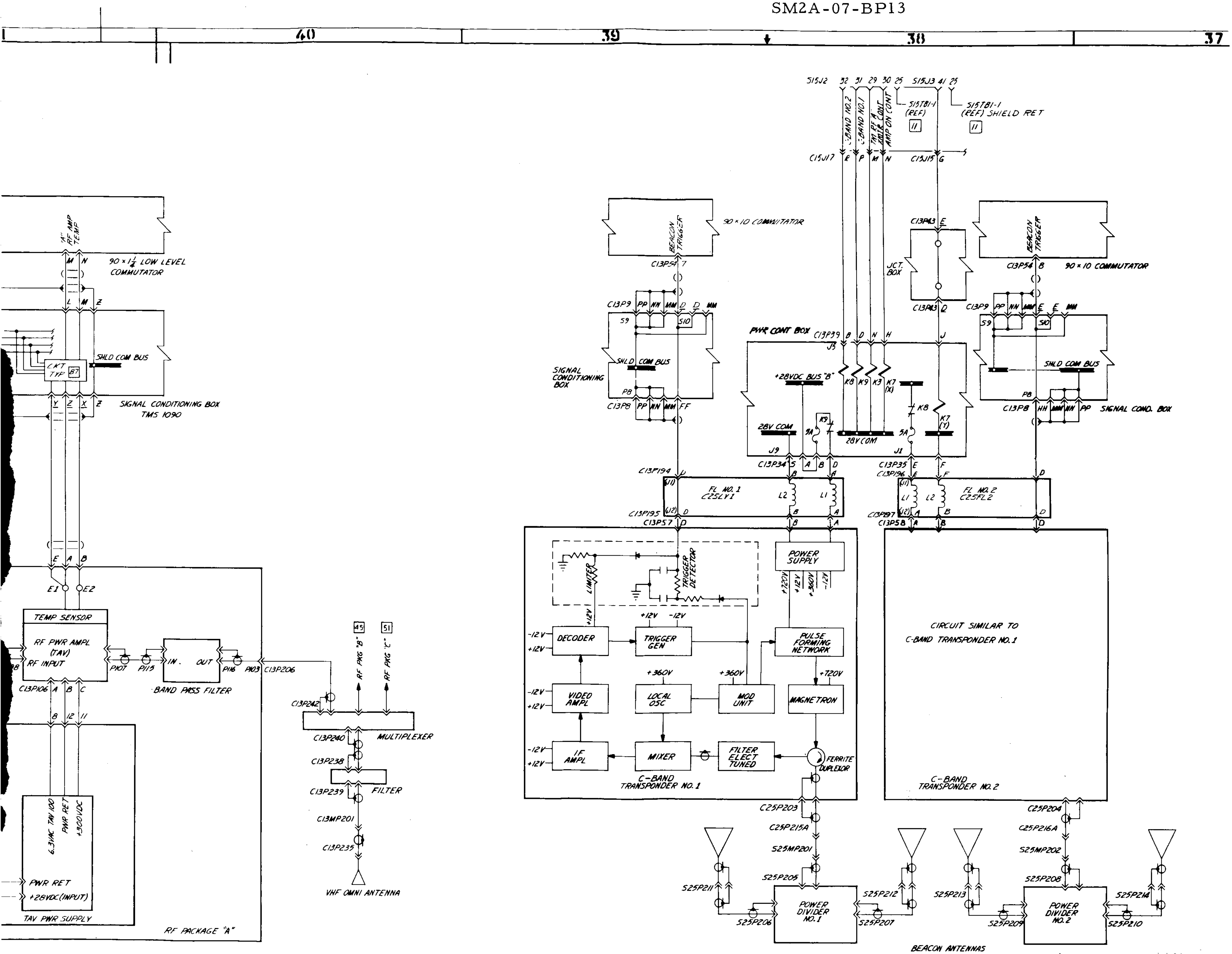
Figure 8-1. Boilerplate 13 Combined Systems Schematic (Dwg B14-90004, Chg B) (Sheet 4 of 8)


48
47
46
SIGNAL CONDITIONING BOX
SIG COM BUS NO. 1
SIG COM BUS NO. 2
SIG COM BUS NO. 3
5V BUS
POWER CONT. BOX
INST. BUS
28V COM
TM "B" COMPOSITE VIDEO
TM "B" RF XMTR CONT
SIG GRD
+28VDC FOR TAA & REF SUPPLY
PWR RET
JUNCTION BOX
+28V PULSE FOR MAN. STEPS
NC = AUTO, +28V = MANUAL
+28VDC FOR CALIB RELAYS
COUNTER IN
CLOCK OUT
+28VDC
PWR GRD
CHASSIS GRD
OUTPUT
SIG GRD
+5V REG
CALIBRATOR
+5 REG OUT
CALIBRATION REF SUPPLY
LINE MATCHING AMPL (TAA)
INPUT
XMTR INPUT AMPL (TAA)
FLUCT. PRESS #1
CA0179P
VIBRATION #4
SA0086D
STRAIN GAGE
SA21205
FLUCT. PRESS #3
A0181
FLUCT. PRESS #6
SA1084P
FLUCT. PRESS #9
FLUCT. PRESS #12
FLUCT. PRESS #15
STRAIN #3
STRAIN #6A
LA0200S
ACCEL #2
E13A1/A0011
ACCEL #2
E13A1/A0012
ACCEL #4
C13A6/CA0007A
SPARES
LIMITER
70 KC
52.5KC
40KC
30KC
22KC
14.5KC
10.5KC
7.35KC
5.4KC
3.9KC
3.0KC
2.3KC
1.7KC
1.3KC
.96KC
.73KC
SCO
TYP 16 PLACES
TB3
MODULATION PKG "B"
"B" XMTR TEMP
20V COM
+20VDC
+28VDC
-28VDC
CKT TYP
+28V BUS "A"
POWER CONT. BOX
TEMP SENSOR
RF XMTR (TXV)
+28VDC
+200VDC
PWR RET
HTR RET
+28VDC (TXV 100)
TXV PWR SUPPLY



45
44
43
42
515J13
515TB1-1 (REF) SHIELD RET
11
C15J15
C13P43
C13P42
JUNCTION BOX
54
48
90 × 10 COMMUTATOR
SIG & PWR GRD
SIG & PWR GRD
STANDARD PDM
+28VDC
+28VDC
PAM OUTPUT
FRAME SYNC (TEST)
CLOCK PULSE (TEST)
CHASSIS GRD
P34
P3
SIGNAL CONDITIONING BOX
SIG COM BUS NO. 1
SIG COM BUS NO. 2
SIG COM BUS NO. 3
5V BUS
POWER CONT. BOX
INST. BUS
28V COM
C13P254A
S13J201
TM A COMPOSITE VIDEO
C13P21
C13P45
C13P44
C13P13
C13P39
SIG GRD
+28VDC FOR TAA, PWR RET REF SUPPLY & COMMUTATOR
C13P42
C13P44
+28V PULSE FOR MAN. STEPS
NC = AUTO, +28V = MAN.
+28VDC FOR CALIB. RELAYS
K1
K2
K3
K4
K5
COUNTER IN
CLOCK OUT
+28VDC
PWR GRD
CHASSIS GRD
OUTPUT
SIG GRD
+5 REG
CALIBRATOR
+5 REG OUT
+28VDC
CHASSIS GRD
SIG GRD
CALIBRATION REF SUPPLY
OUTPUT
+28VDC
CHASSIS GRD
INPUT
SIG GRD
LINE MATCHING AMPL (TAA)
+27VDC
CHASSIS GRD
INPUT
SIG GRD
XMTR INPUT AMPL (TAA)
C13P205
C13P204
C13P207
LIMITER
70KC
40KC
30KC
22KC
14.5KC
10.5KC
7.35KC
5.4KC
3.9KC
3.0KC
2.3KC
1.7KC
1.3KC
.96KC
.73KC
.56KC
SCO
TB3
TYP 16 PLACES
MODULATION PKG "A"
C13P45
VIBRATION #1
A0021
C13P9
FLUCT. PRESS #4
SA1082
FLUCT. PRESS #7
SA1085P
C13P11-A
PAM
74
FLUCT. PRESS #10
SA1088P
FLUCT. PRESS #13
SA1091P
C13P11
STRAIN #2
STRAIN #1
STRAIN #8A
LA02C25
STRAIN #7A
LA0201S
C13P9-DD
ACCEL #7
S13A10/SA0004A
SPARES
54
64
66
69
70
57
57
71
72
59
"B" RF AMP TEMP
90 × 1¼ LOW LEVEL COMMUTATOR
SHLD COM BUS
CKT TYP 87
SIGNAL CONDITIONING BOX TMS 1090
E1
E2
TEMP SENSOR
RF PWR AMPL (TAV)
RF INPUT
C13P106
P107
P115
IN
OUT
P116
P103
C13P233
BAND PASS FILTER
C13P243
MULTIPLEXER
40
6.3VAC TAV 100
PWR RET
+300VDC
PWR RET
+28VDC (INPUT)
TAV PWR SUPPLY
RF PACKAGE "B"
"A" XMTR TEMP
C13P149
C13P160
J7
CKT TYP 87
C13P154
+28VDC BUS "A"
K3
K7
28V COM
PWR CONT BOX
C13P35
C13P56
J10
SPARE
E7
E8
E3
E4
TEMP SENSOR
RF XMTR (TXV)
P105
C13P104
C13P117
+28VDC
+200VDC
PWR RET
HTR RET
+28VDC (TXV100)
PWR RET
+28VDC
TXV PWR SUPPLY

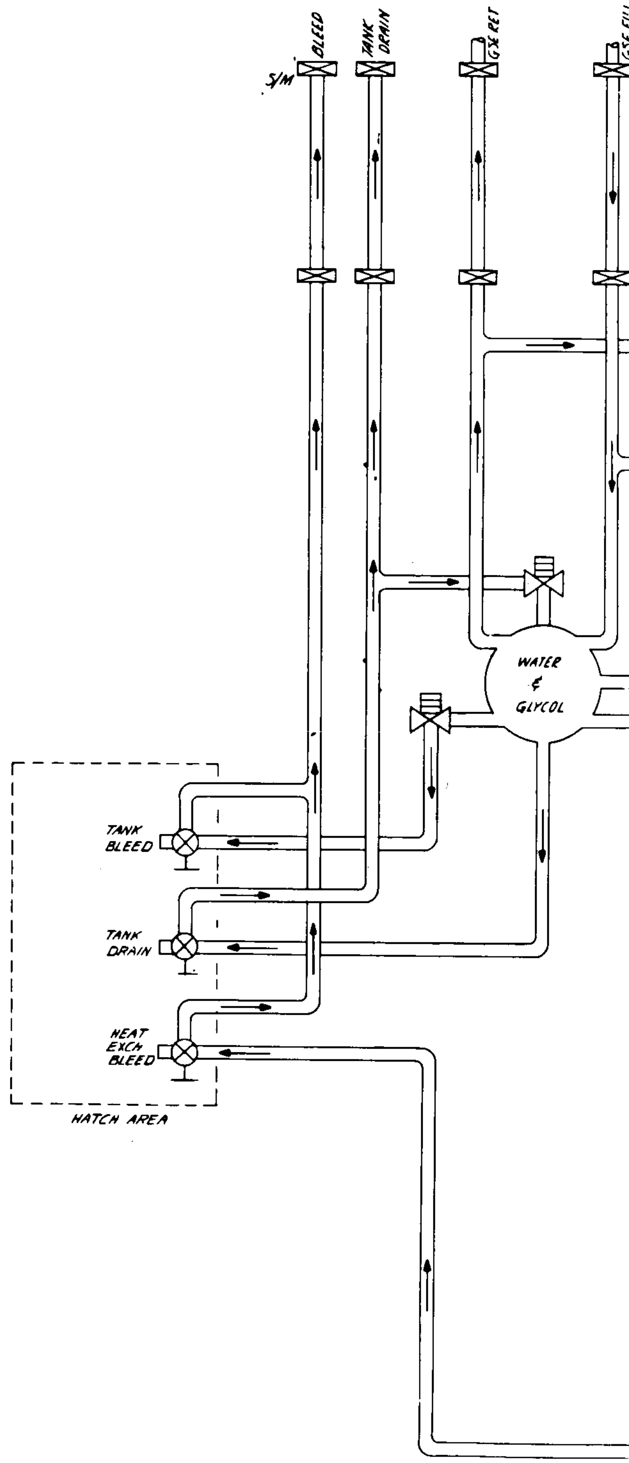
2



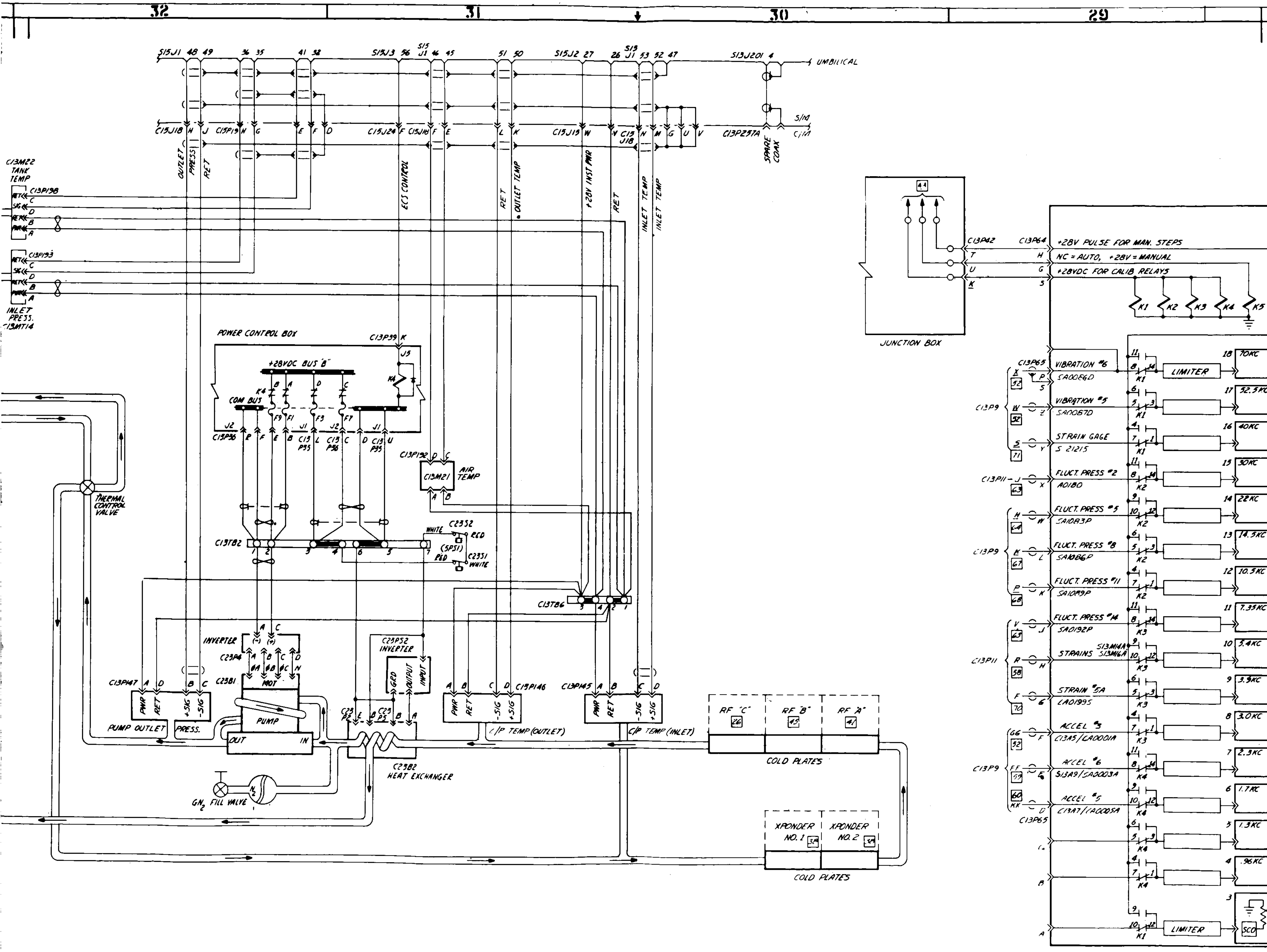
SM-4A-264A

Figure 8-1. Boilerplate 13 Combined Systems Schematic (Dwg B14-90004, Chg A) (Sheet 5 of 8)

36 35 34 33

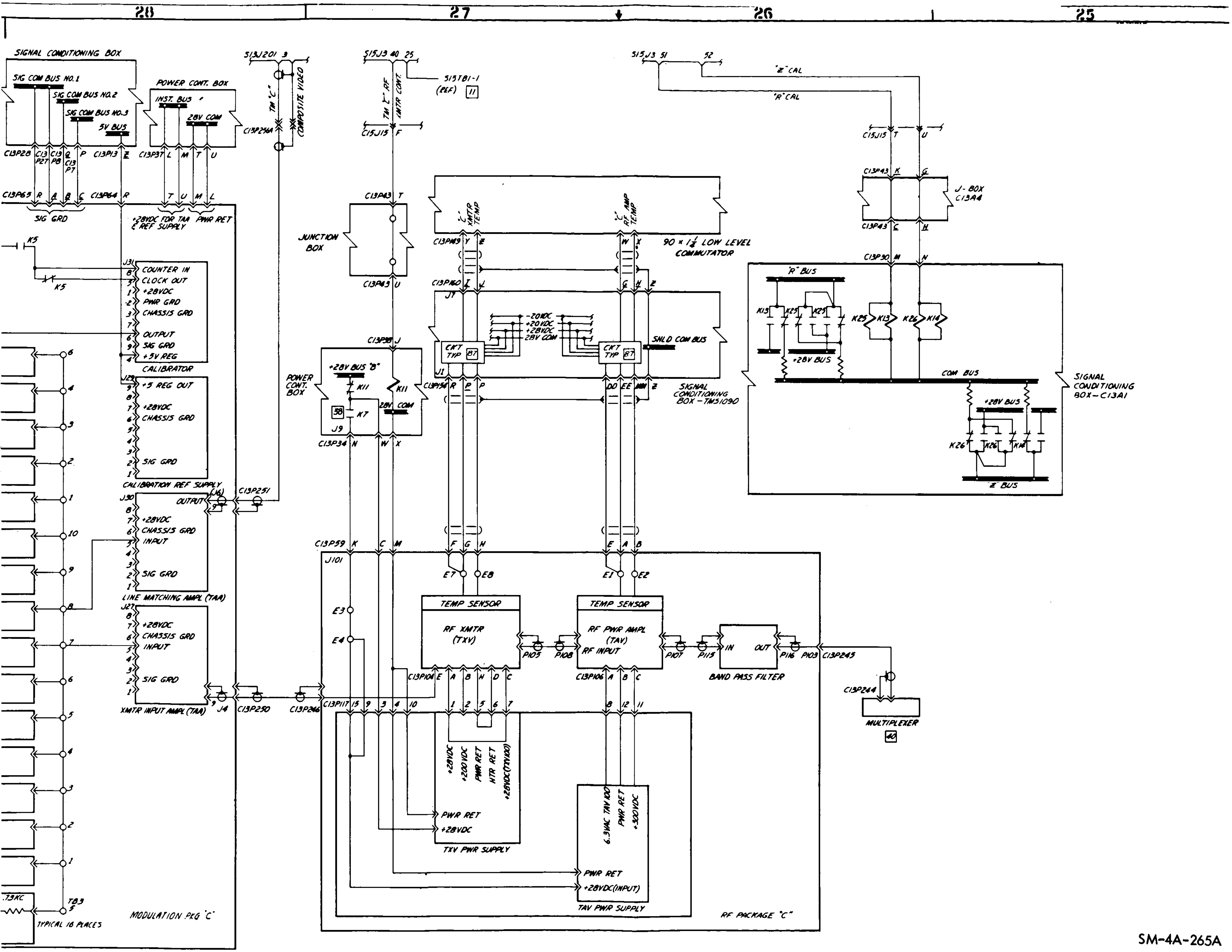


S/M
BLEED
TANK DRAIN
GSE RET
WATER & GLYCOL
TANK BLEED
TANK DRAIN
HEAT EXCH BLEED
HATCH AREA



32
31
30
29
UMBILICAL
C13M22 TANK TEMP
INLET PRESS. C13MT14
OUTLET PRESS
RET
ECS CONTROL
OUTLET TEMP
+28V INST PWR
INLET TEMP
SPARE COAX
POWER CONTROL BOX
+28VDC BUS "B"
COM BUS
AIR TEMP
THERMAL CONTROL VALVE
INVERTER
C23P52 INVERTER
PUMP
PUMP OUTLET
PRESS.
C/P TEMP (OUTLET)
C/P TEMP (INLET)
C23B2 HEAT EXCHANGER
GN2 FILL VALVE
RF "C"
RF "B"
RF "A"
COLD PLATES
XPONDER NO. 1
XPONDER NO. 2
COLD PLATES
JUNCTION BOX
+28V PULSE FOR MAN. STEPS
NC = AUTO, +28V = MANUAL
+28VDC FOR CALIB RELAYS
VIBRATION #6
SA00E6D
VIBRATION #5
SA0067D
STRAIN GAGE
S 21215
FLUCT. PRESS #2
A0180
FLUCT. PRESS #5
SA10B3P
FLUCT. PRESS #8
SA1086P
FLUCT. PRESS #11
SA1089P
FLUCT. PRESS #14
SA0192P
STRAINS
STRAIN #5A
CA01995
ACCEL #3
C13A5/CA0001A
ACCEL #6
S13A9/CA0003A
ACCEL #5
C13A7/CA0005A
LIMITER
LIMITER
SCO
70KC
52.5KC
40KC
30KC
22KC
14.5KC
10.5KC
7.35KC
5.4KC
3.9KC
3.0KC
2.3KC
1.7KC
1.3KC
.96KC

2

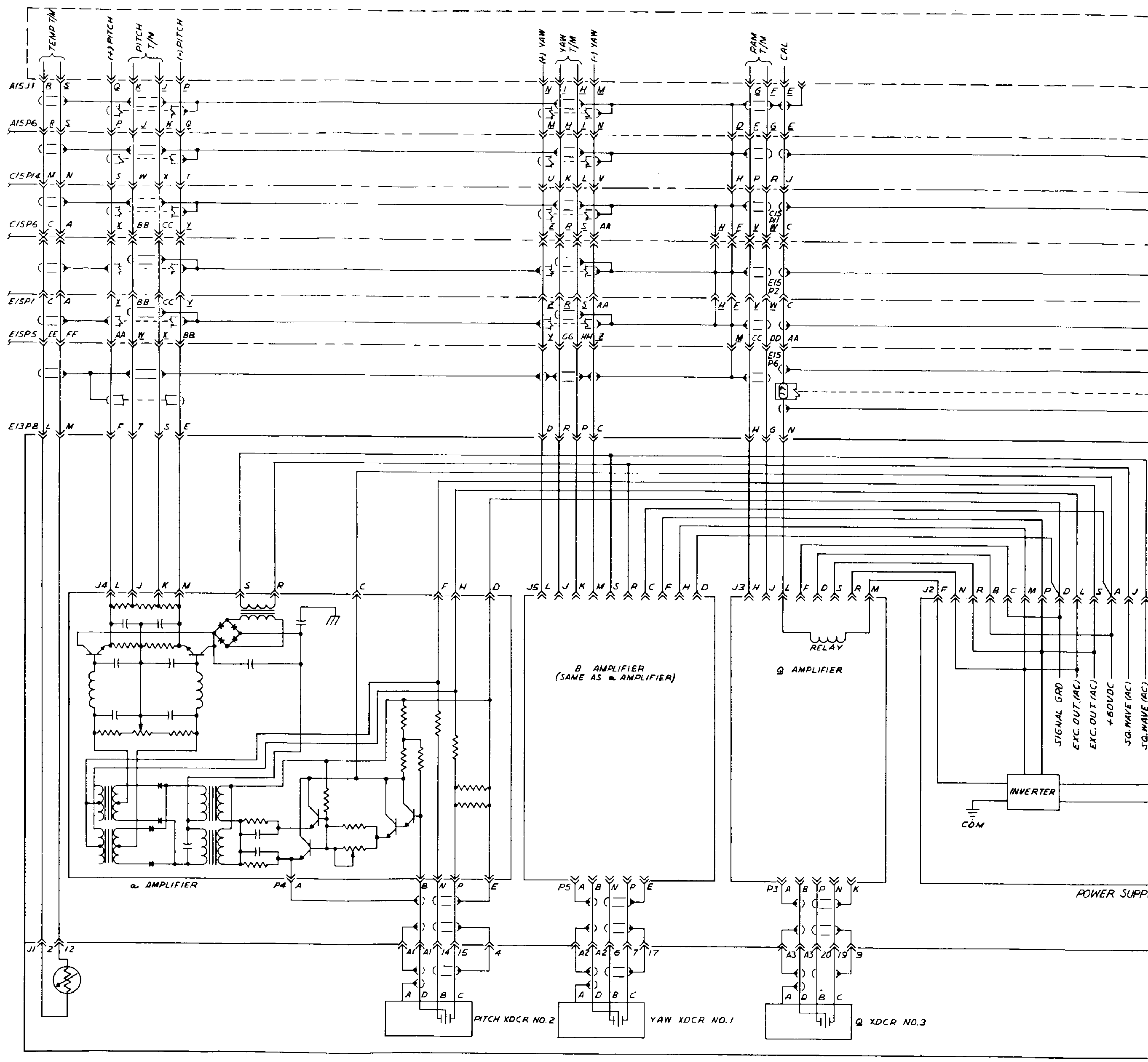


SM-4A-265A

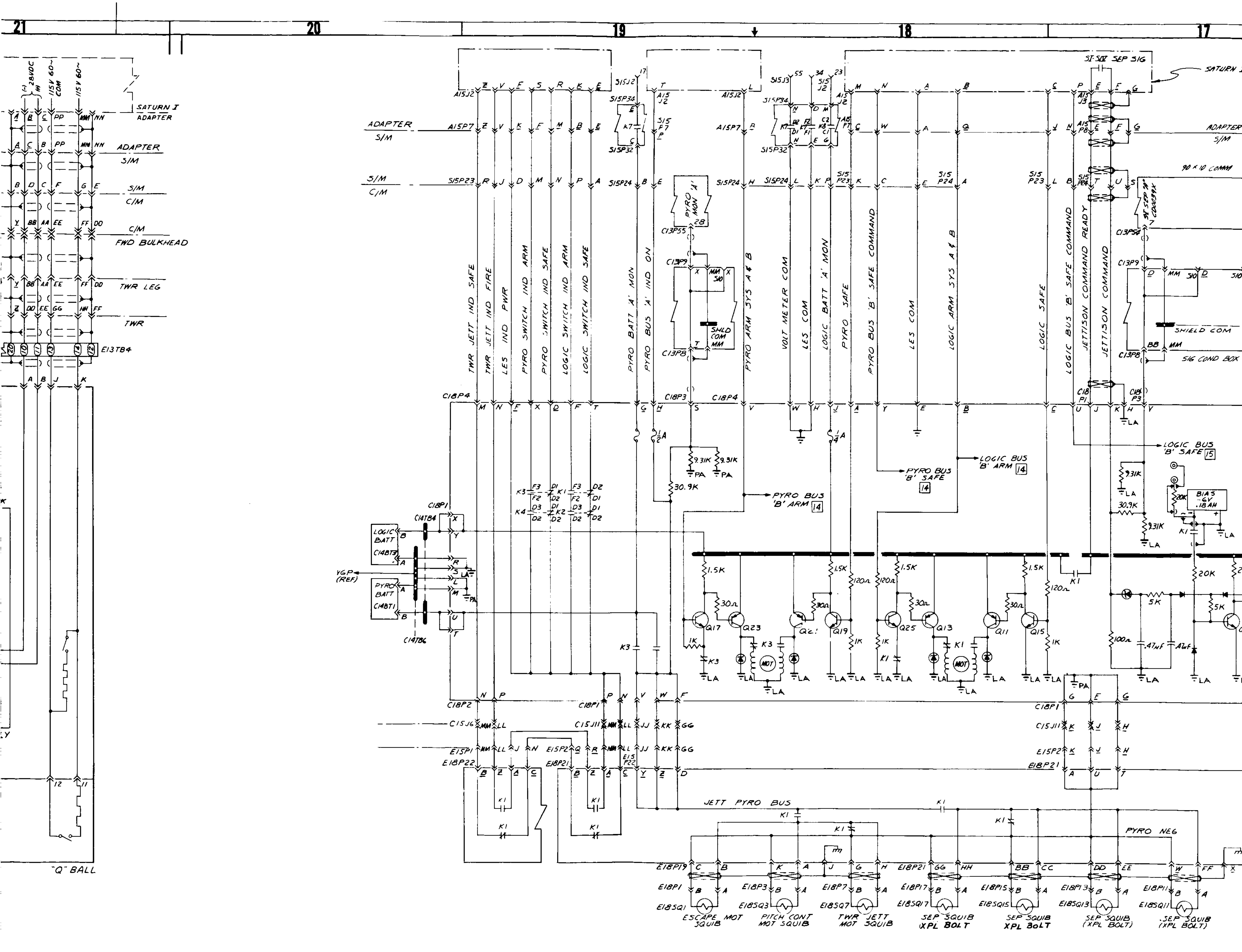
Figure 8-1. Boilerplate 13 Combined Systems Schematic (Dwg B14-90004, Chg A) (Sheet 6 of 8)

3

24 23 22



TEMP T/M
(+) PITCH
PITCH T/M
(-) PITCH
(+) YAW
YAW T/M
(-) YAW
RAM T/M
CAL
A15J1
A15P6
C15P14
C15P6
E15P1
E15P5
E13P8
C15 P1
E15 P2
E15 P6
J4
J5
J3
J2
RELAY
B AMPLIFIER (SAME AS α AMPLIFIER)
Q AMPLIFIER
α AMPLIFIER
P4
P5
P3
SIGNAL GRD
EXC. OUT. (AC)
EXC. OUT. (AC)
+60VDC
SQ. WAVE (AC)
SQ. WAVE (AC)
INVERTER
COM
POWER SUPP
J1
PITCH XDCR NO.2
YAW XDCR NO.1
Q XDCR NO.3


21
20
19
18
17
SATURN I ADAPTER
(-) 28VDC
115V 60~ COM
115V 60~
ADAPTER S/M
S/M C/M
C/M FWD BULKHEAD
TWR LEG
TWR
E13TB4
"Q" BALL
A15J2
A15P7
S15P23
S15P24
S15P34
S15P32
S15J3
S15J2
TWR JETT IND SAFE
TWR JETT IND FIRE
LES IND PWR
PYRO SWITCH IND ARM
PYRO SWITCH IND SAFE
LOGIC SWITCH IND ARM
LOGIC SWITCH IND SAFE
PYRO BATT 'A' MON
PYRO BUS 'A' IND ON
PYRO ARM SYS A & B
PYRO MON 'A'
C13P55
C13P9
C13P8
SHLD COM MM
VOLT METER COM
LES COM
LOGIC BATT 'A' MON
PYRO SAFE
PYRO BUS 'B' SAFE COMMAND
LOGIC ARM SYS A & B
LOGIC SAFE
LOGIC BUS 'B' SAFE COMMAND
JETTISON COMMAND READY
JETTISON COMMAND
SI-SIV SEP SIG
SATURN
90 × 10 COMM
SHIELD COM
SIG COND BOX
C18P4
C18P3
C18P1
C18P2
C14TB4
C14BT3
C14BT1
C14TB6
LOGIC BATT
PYRO BATT
VGP (REF)
PYRO BUS 'B' ARM 14
PYRO BUS 'B' SAFE 14
LOGIC BUS 'B' ARM 14
LOGIC BUS 'B' SAFE 15
BIAS -6V .18 AH
C15J6
C15J11
E15P1
E15P2
E18P22
E18P21
JETT PYRO BUS
PYRO NEG
E18P19
E18P1
E18SQ1
ESCAPE MOT SQUIB
E18P3
E18SQ3
PITCH CONT MOT SQUIB
E18P7
E18SQ7
TWR JETT MOT SQUIB
E18P17
E18SQ17
SEP SQUIB XPL BOLT
E18P15
E18SQ15
SEP SQUIB XPL BOLT
E18P13
E18SQ13
SEP SQUIB (XPL BOLT)
E18P11
E18SQ11
SEP SQUIB (XPL BOLT)

2

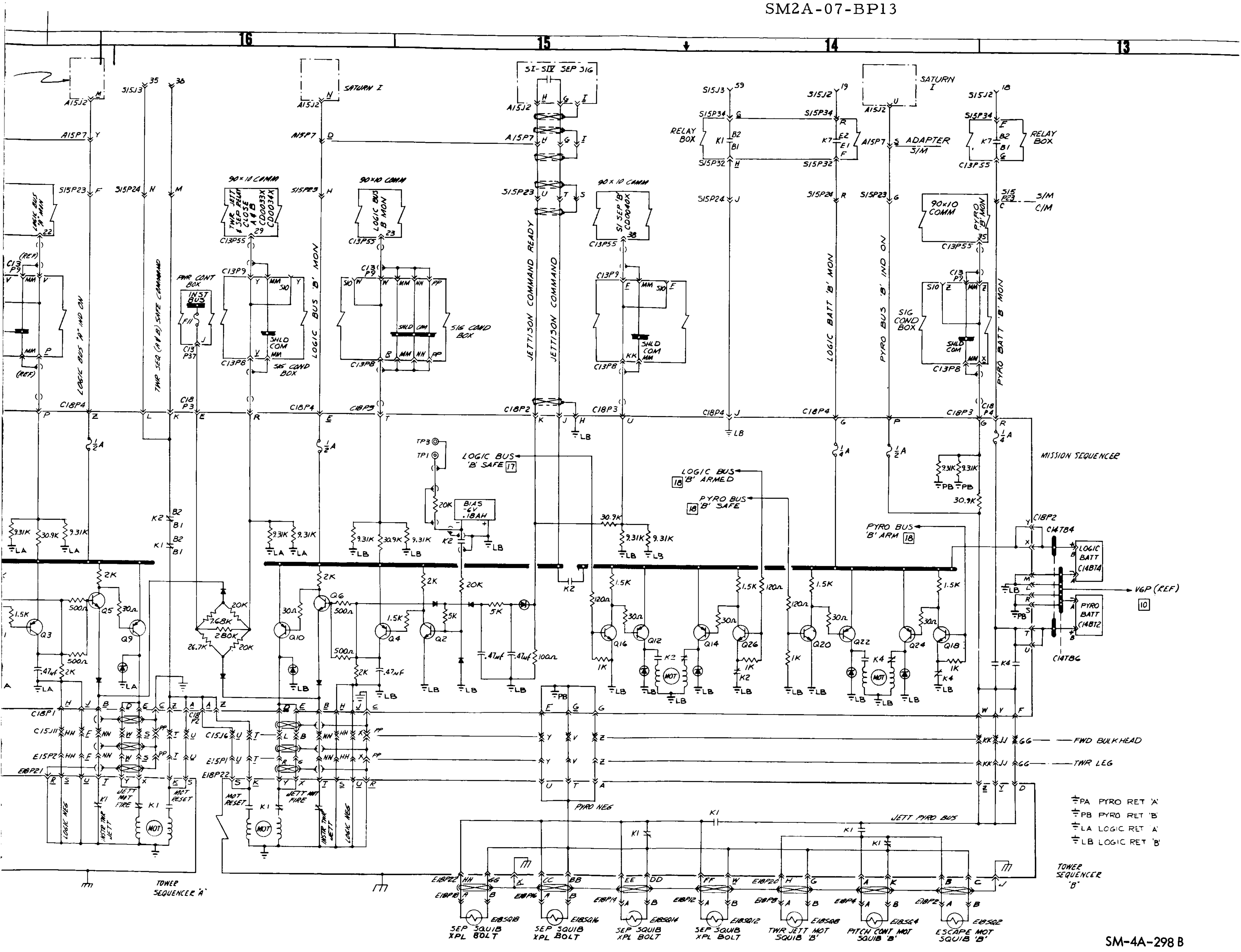
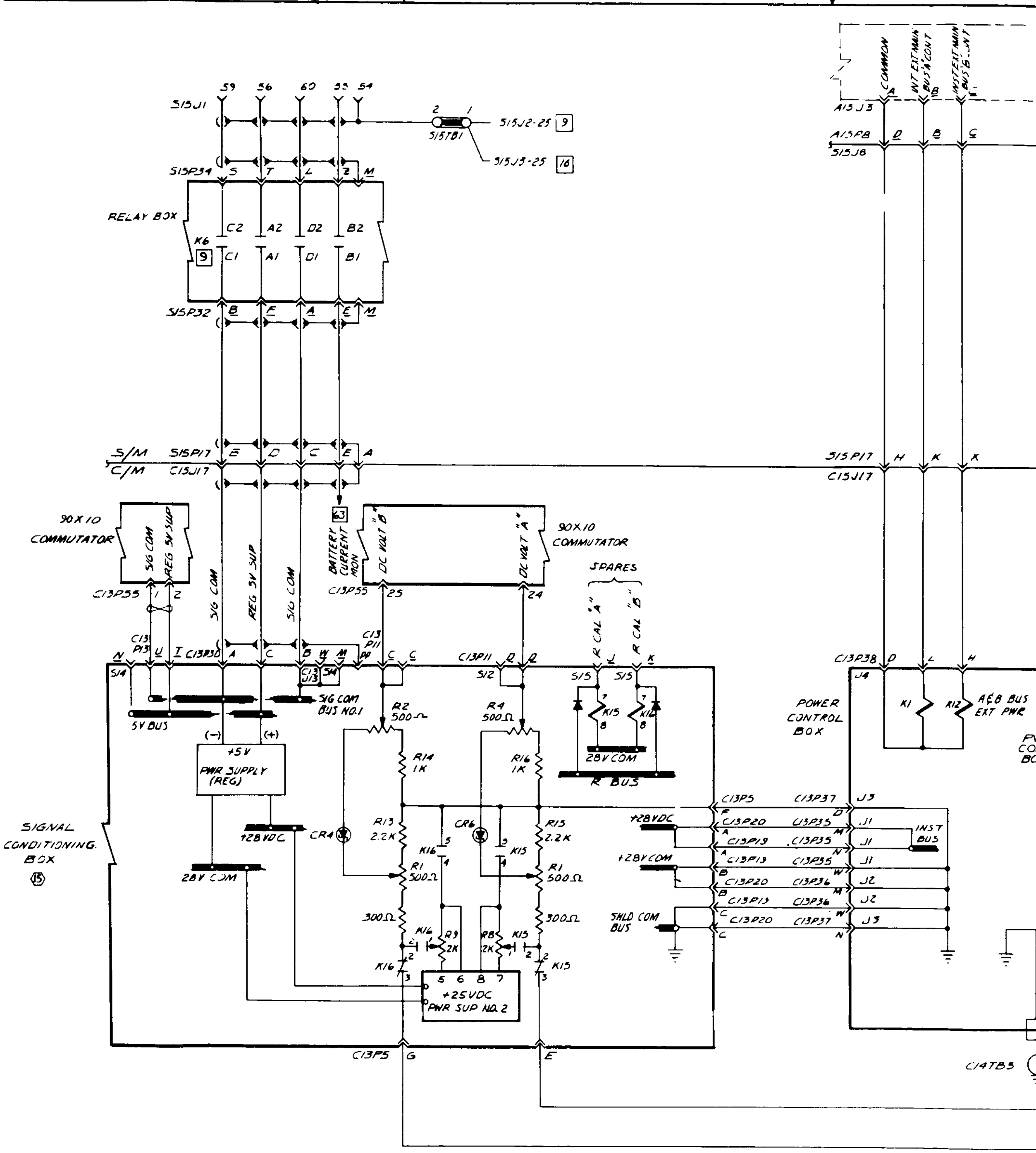
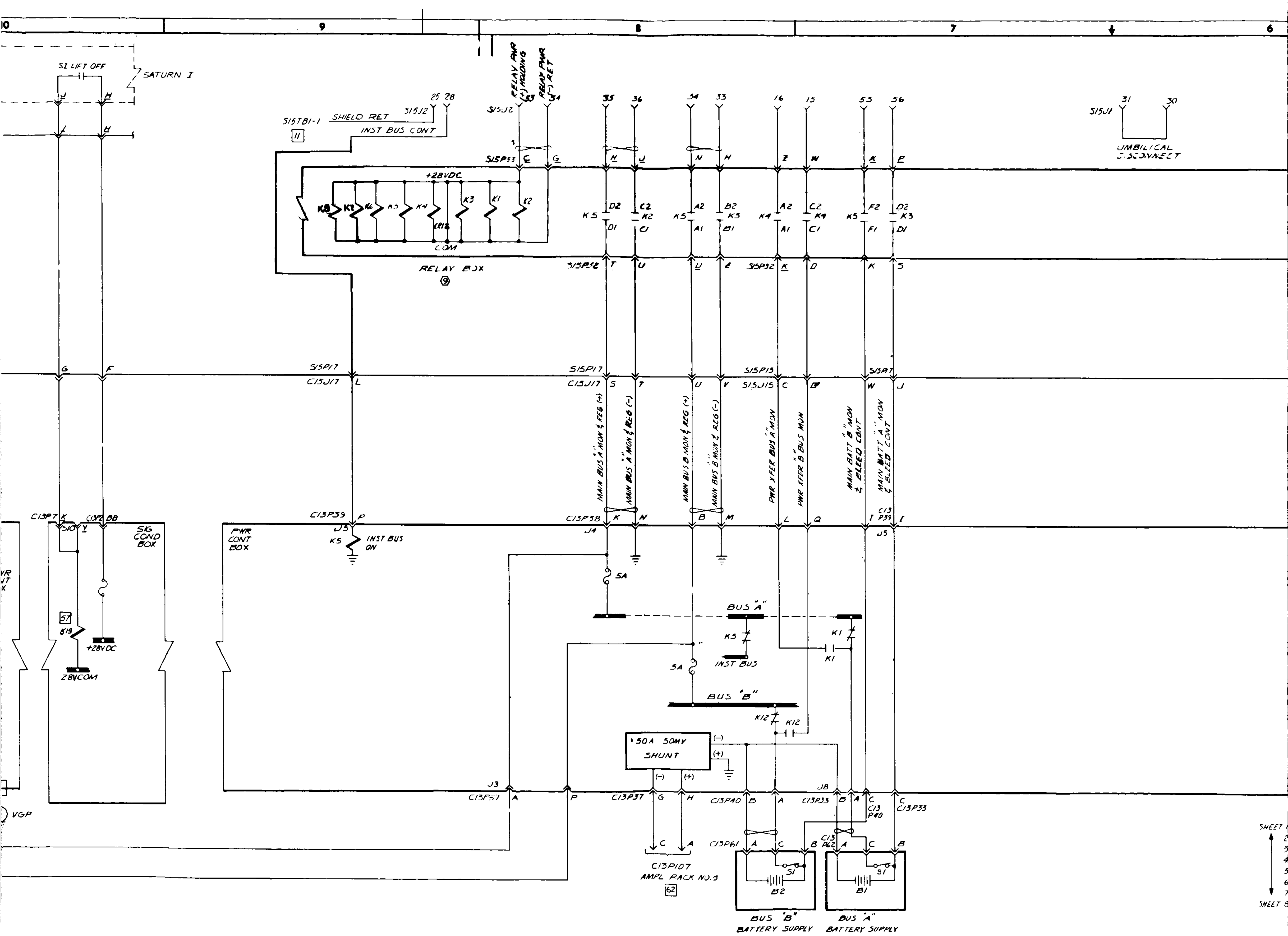


Figure 8-1. Boilerplate 13 Combined Systems Schematic (Dwg B14-90004, Chg B) (Sheet 7 of 8)

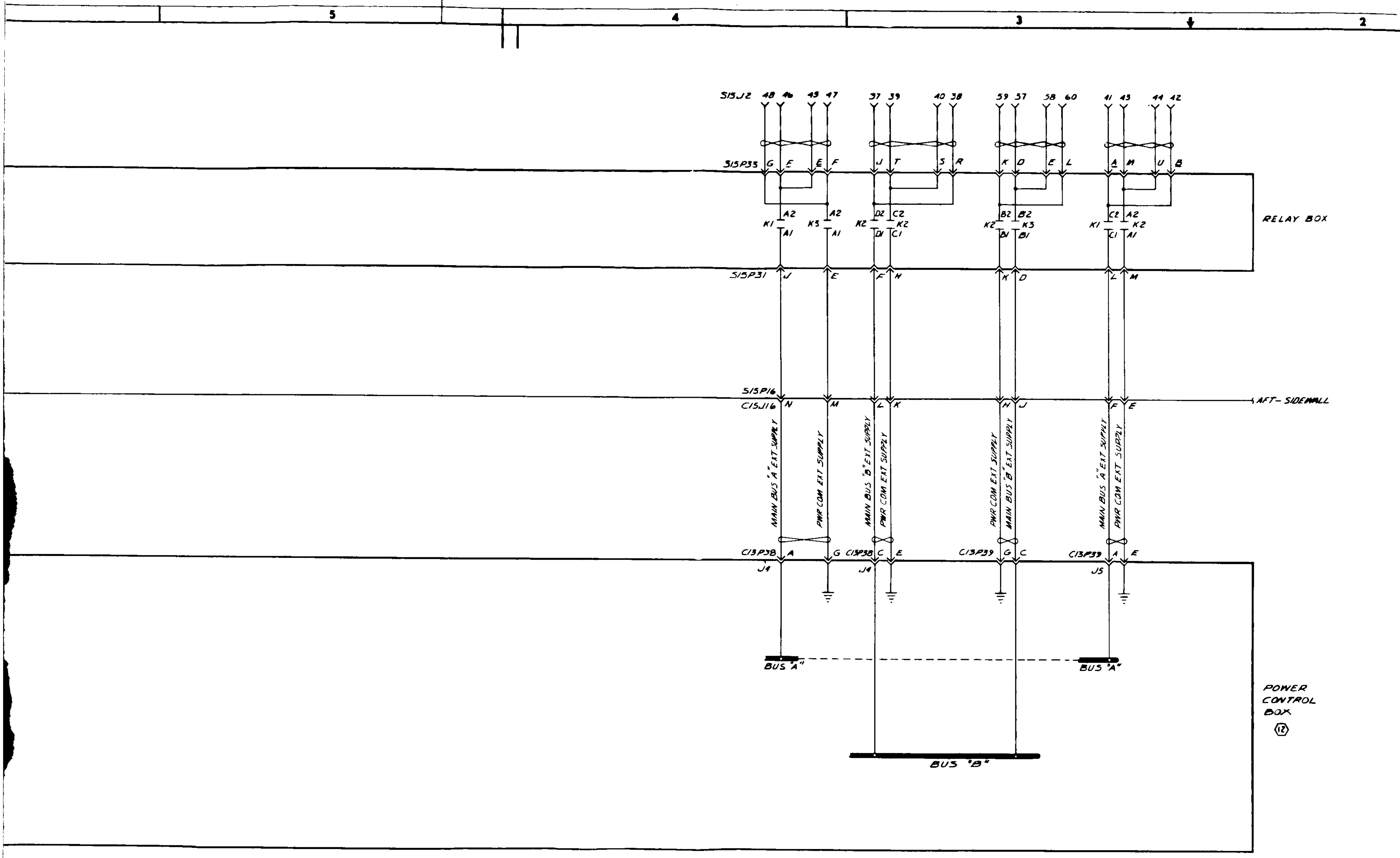
3


S15J1
S15TB1
S15J2-25 9
S15J3-25 16
S15P34
RELAY BOX
K6 9
S15P32
S/M S15P17
C/M C15J17
90X10 COMMUTATOR
SIG COM
REG 5V SUP
C13P55
63
BATTERY CURRENT MON
DC VOLT "B"
DC VOLT "A"
SPARES
R CAL "A"
R CAL "B"
SIG COM BUS NO.1
5V BUS
+5V PWR SUPPLY (REG)
+28VDC
28V COM
R BUS
SIGNAL CONDITIONING BOX 15
+25VDC PWR SUP NO.2
C13P5
COMMON
INT EXT MAIN BUS A CONT
INT EXT MAIN BUS B CONT
A15J3
A15P8
S15J8
S15P17
C15J17
C13P38
POWER CONTROL BOX
A&B BUS EXT PWR
+28VDC
+28V COM
SHLD COM BUS
INST BUS
C14TB5



10
9
8
7
6
S1 LIFT OFF
SATURN I
RELAY PWR (+) HOLDING
RELAY PWR (-) RET
S15TB1-1
SHIELD RET
INST BUS CONT
S15J2
S15P33
+28VDC
COM
RELAY BOX
9
S15P32
UMBILICAL DISCONNECT
S15J1
S15P17
C15J17
S15P15
S15J15
MAIN BUS "A" MON & REG (+)
MAIN BUS "A" MON & REG (-)
MAIN BUS B MON & REG (+)
MAIN BUS B MON & REG (-)
PWR XFER BUS "A" MON
PWR XFER "B" BUS MON
MAIN BATT "B" MON & BLEED CONT
MAIN BATT "A" MON & BLEED CONT
C13P7
C13P39
C13P38
SIG COND BOX
PWR CONT BOX
INST BUS ON
28VCOM
+28VDC
BUS "A"
BUS "B"
INST BUS
50A 50MV SHUNT
C13P37
C13P40
C13P33
C13P61
C13P62
C13P107
AMPL RACK NO.3
62
BUS "B" BATTERY SUPPLY
BUS "A" BATTERY SUPPLY
VGP

2



SYSTEM INDEX
POWER DISTRIBUTION
LES SEQUENCER
ECS & TELEMETRY
TELEMETRY
INSTRUMENTATION (ACCEL, VIB AMPL & STRAIN GA).
(FLUCT PRESS., INT PRESS XDUCER & STRAIN GA).
(CALORIMETER & ZONE BOX).
INSTRUMENTATION (CALORIMETER, RES THERM, INT TEMP & ZONE BOX).

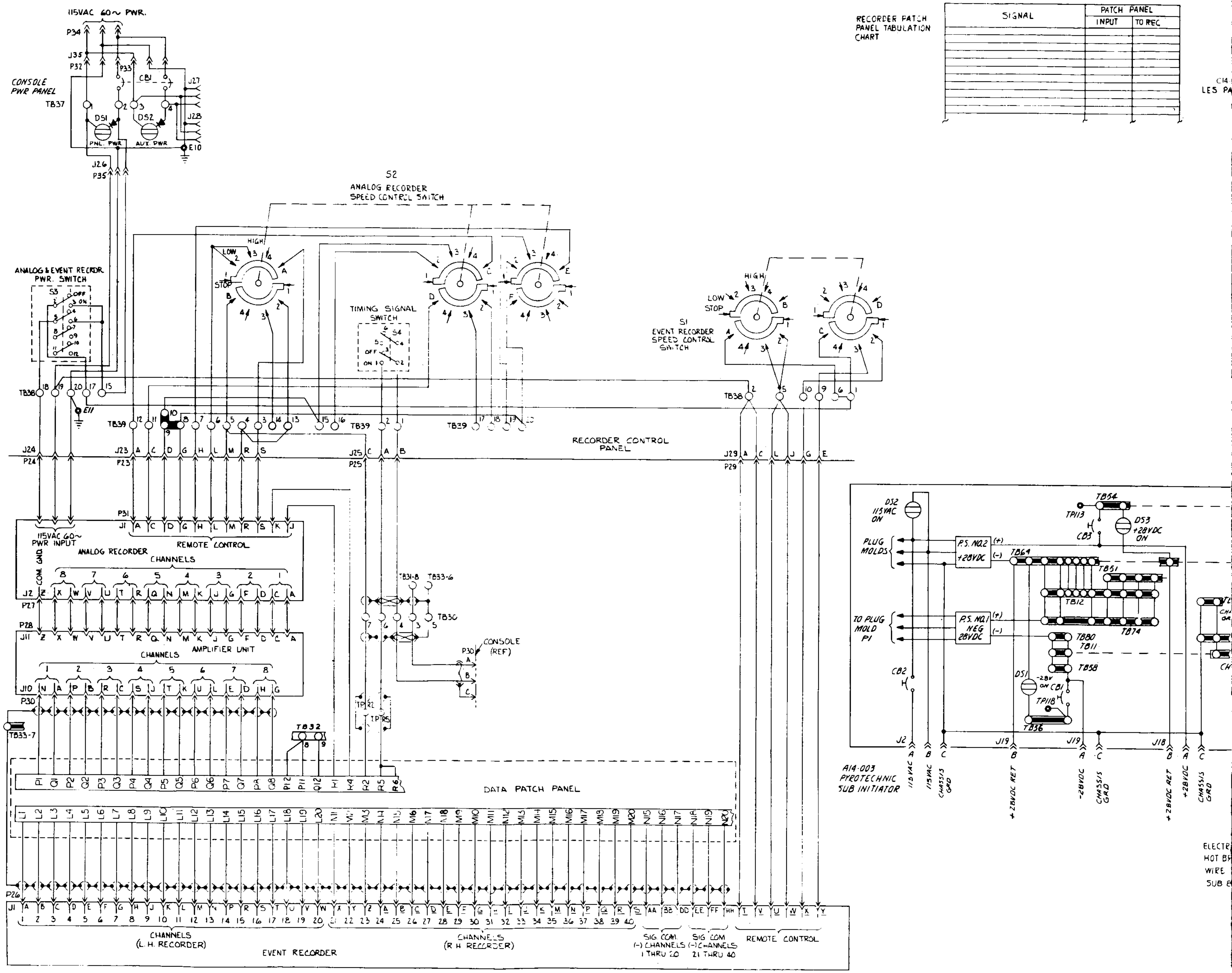
17 FOR WIRING DIAG TWR SEQUENCER SEE B15-945901.
16 SEQUENCER SEE B16-450220.
15 SC BOX SEE NASA DWG SX530060
14 J-BOX SEE NASA DWG SC530013
13 RF PKG SEE NASA DWG SD530136
12 PCB SEE NASA DWG SX540007.
11 SEE B16-450210.
10 RELAY BOX SEE B16-450208.
9 RELAY BOX SEE B17-450221.
8 SEE B17-450208.
7 FOR WIRING DIAG SEE B18-450201.
6 FOR SCHEM DIAG PCB SEE NASA DWG SX530170.
5 ACCEL SB530010.
4 VIB AMPL SC510063.
3 FLUCT PRESS SB530016.
2 ZONE BOX SC550008.
1 FOR SCHEM DIAG STRAIN GAUGE SEE NASA DWG SB530017.
NOTES: UNLESS OTHERWISE SPECIFIED.

24. FOR GSE & SPACECRAFT GROUNDING SCHEMATIC SEE B14-900105.
23. FOR CABLING DIAGRAM SEE B14-900104.
22. FOR MATING GSE INTERGRATED SCHEMATIC SEE G14-900004
21. ALL RELAYS ARE SHOWN IN THE UNENERGIZED POSITION.
20. UNDERLINED LETTERS DENOTE LOWER CASE.
19 FOR SCHEM DIAG MOD B & C SEE NASA DWG SX530097.
18 FOR SCHEM DIAG MOD A SEE NASA DWG SX530135

SM-4A-267C

Figure 8-1. Boilerplate 13 Combined Systems Schematic (Dwg B14-90004, Chg C) (Sheet 8 of 8)

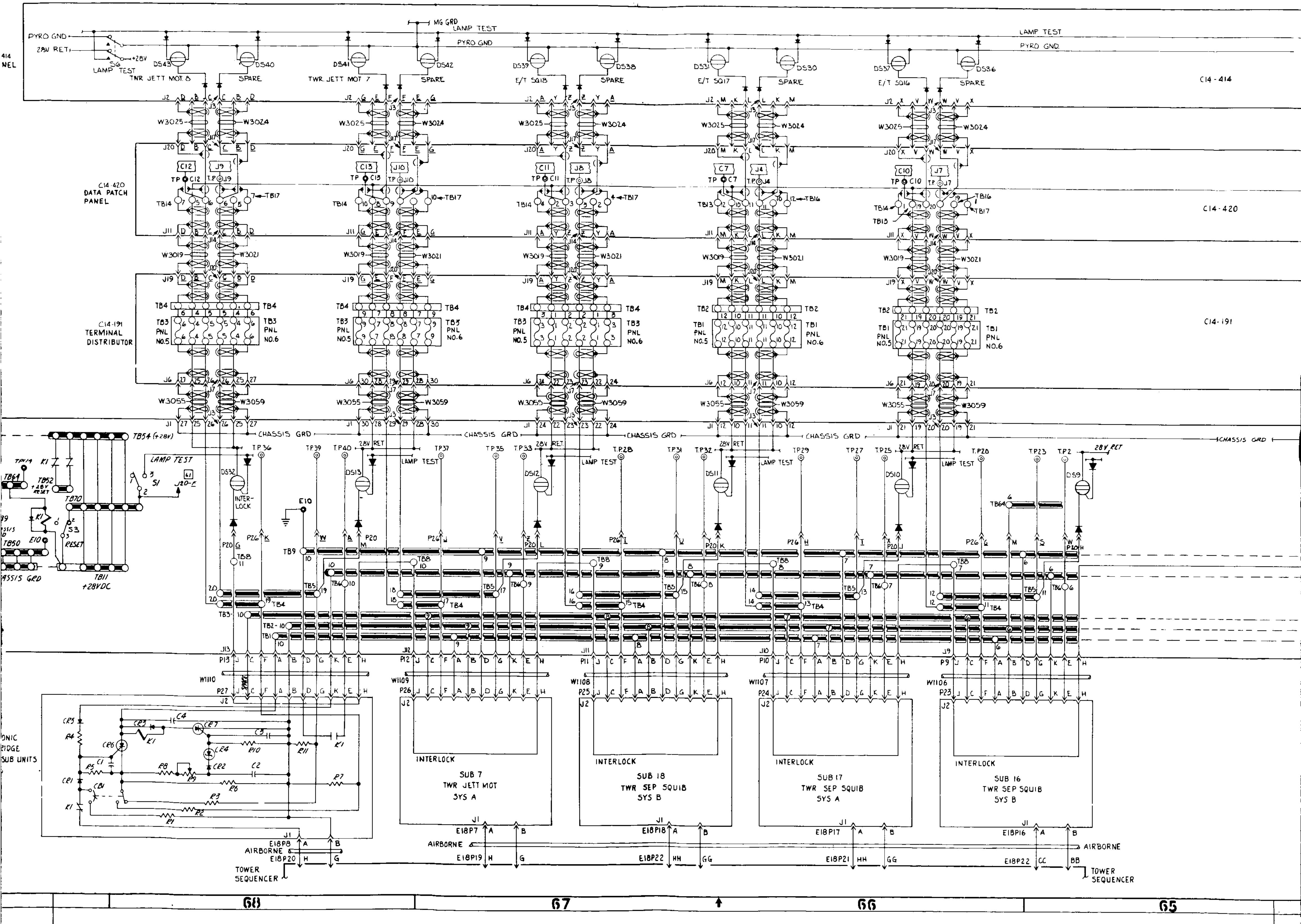
3



RECORDER PATCH PANEL TABULATION CHART

SIGNAL	PATCH PANEL	
	INPUT	TO REC

72 71 70 69



PYRO GND
28V RET
LAMP TEST
MG GRD
TWR JETT MOT 8
SPARE
TWR JETT MOT 7
E/T SQ18
E/T SQ17
E/T SQ16
C14-414
C14-420
DATA PATCH
PANEL
C14-420
C14-191
TERMINAL
DISTRIBUTOR
C14-191
CHASSIS GRD
INTERLOCK
SUB 7
TWR JETT MOT
SYS A
SUB 18
TWR SEP SQUIB
SYS B
SUB 17
TWR SEP SQUIB
SYS A
SUB 16
TWR SEP SQUIB
SYS B
AIRBORNE
TOWER
SEQUENCER

68 67 66 65

2

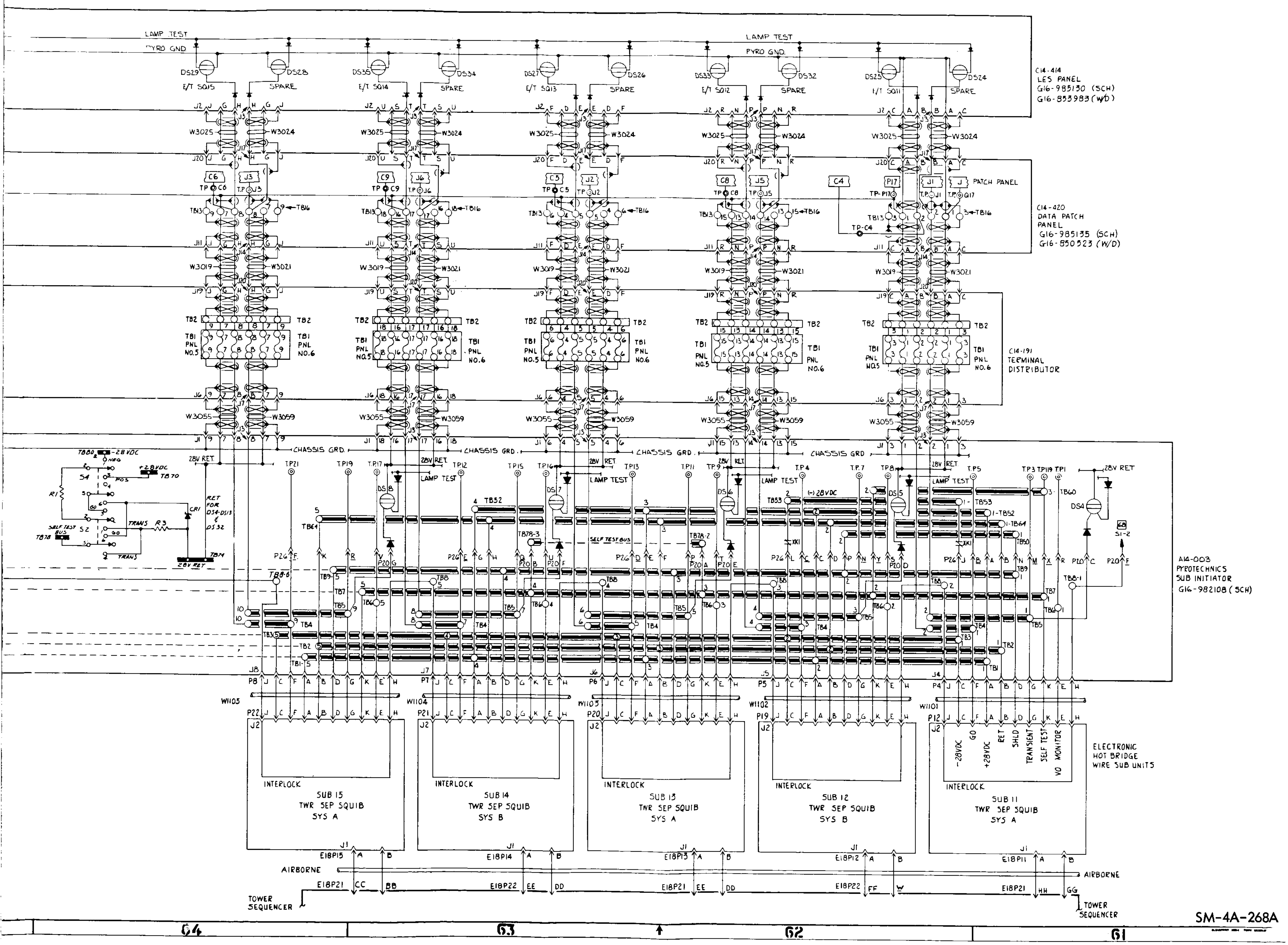
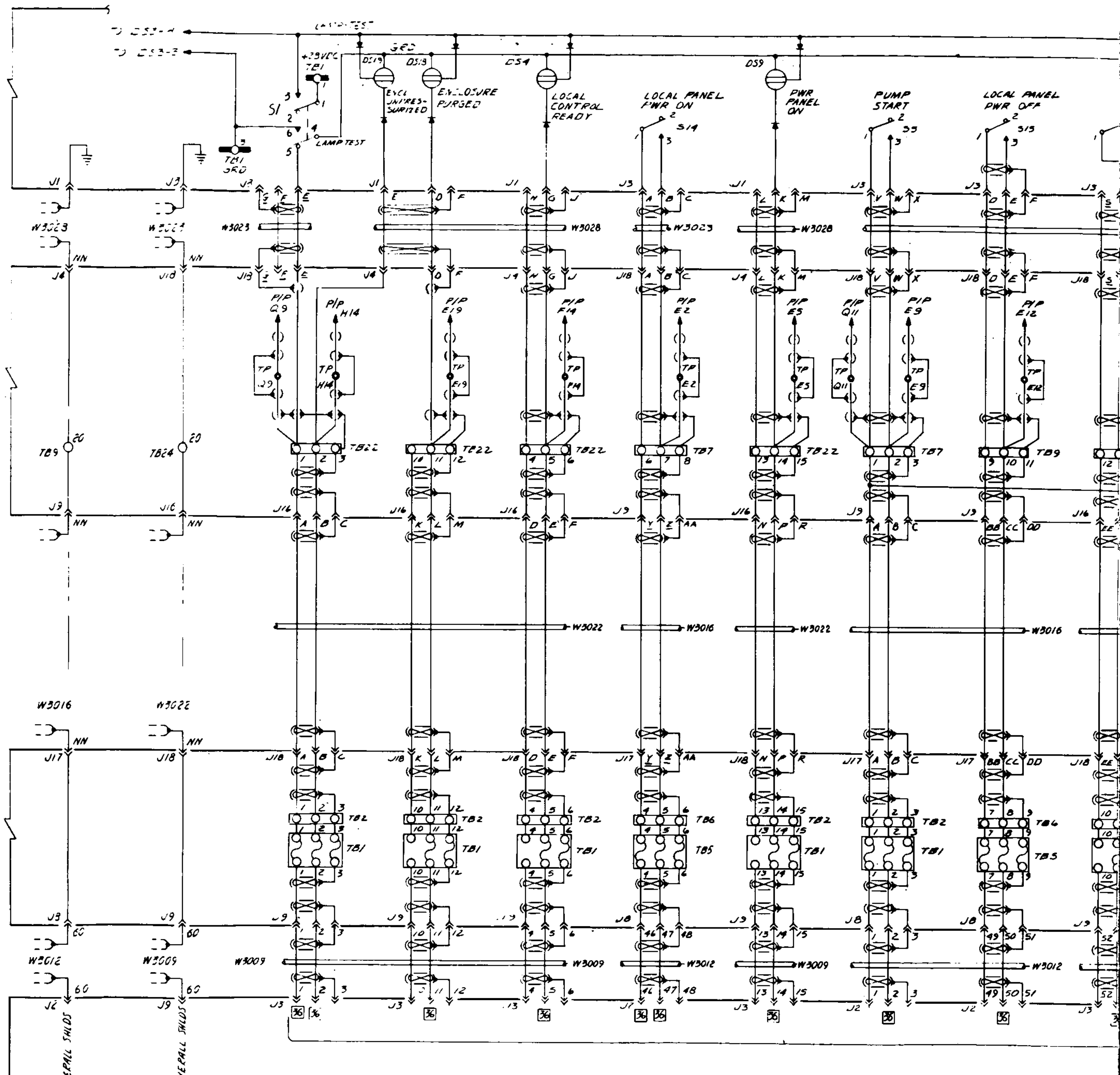
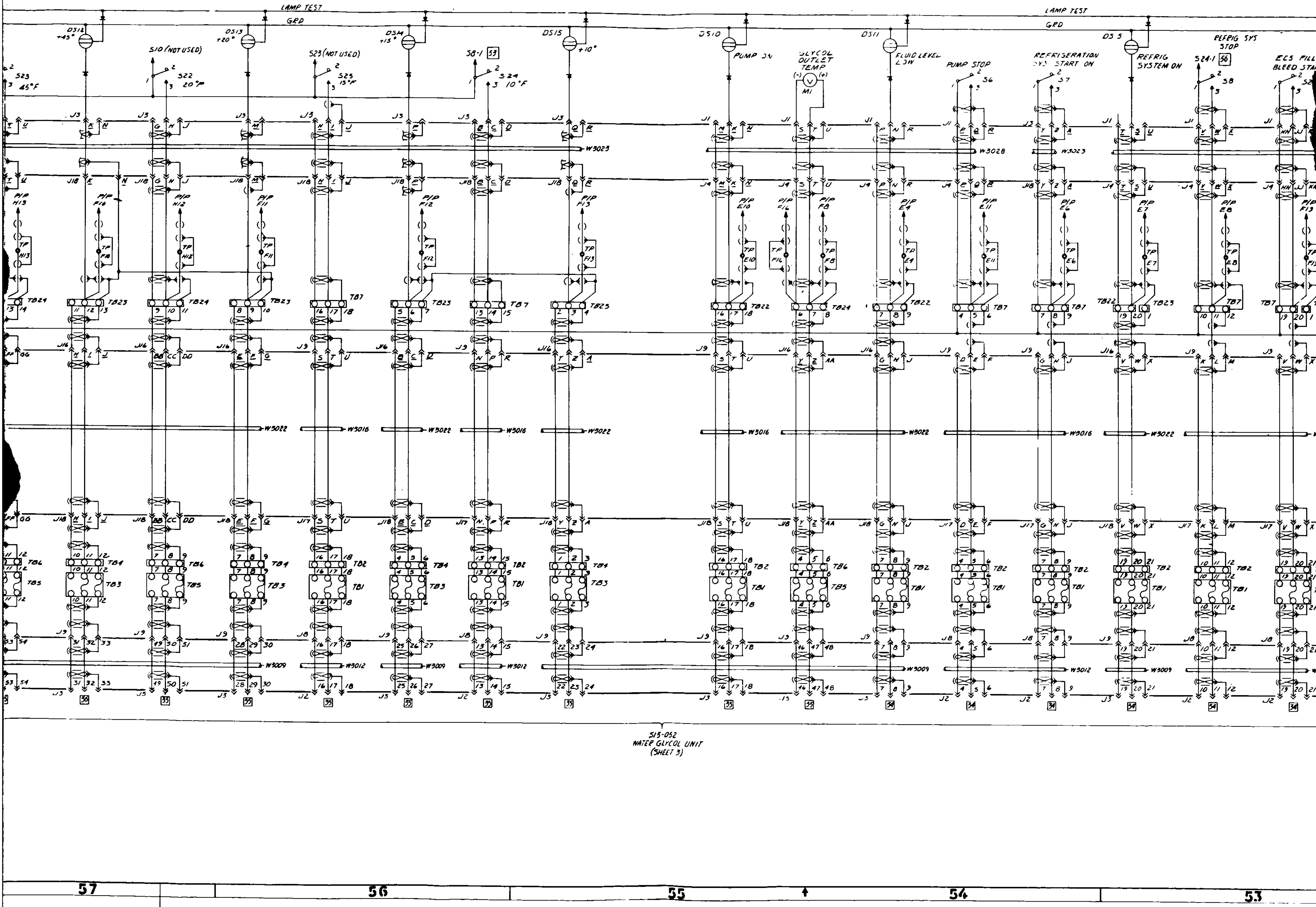


Figure 8-2. GSE Combined Systems Schematic (Dwg G14-90004)
(Sheet 1 of 6)

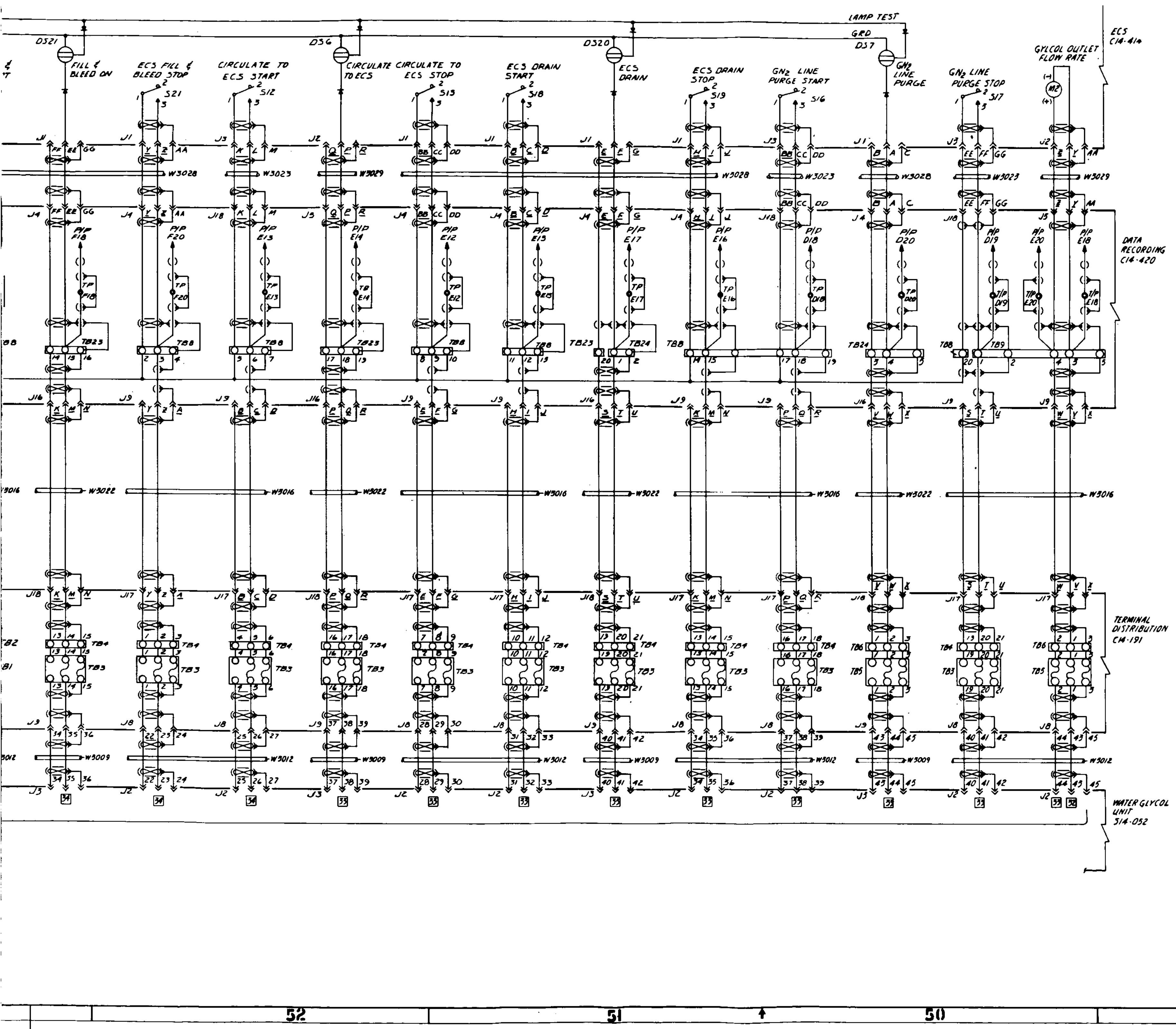
3



60 59 58


LAMP TEST
GRD
PUMP ON
GLYCOL OUTLET TEMP
FLUID LEVEL LOW
PUMP STOP
REFRIGERATION SYS START ON
REFRIG SYSTEM ON
REFRIG SYS STOP
S10 (NOT USED)
S23 (NOT USED)
515-052
WATER GLYCOL UNIT
(SHEET 3)
57
56
55
54
53

2

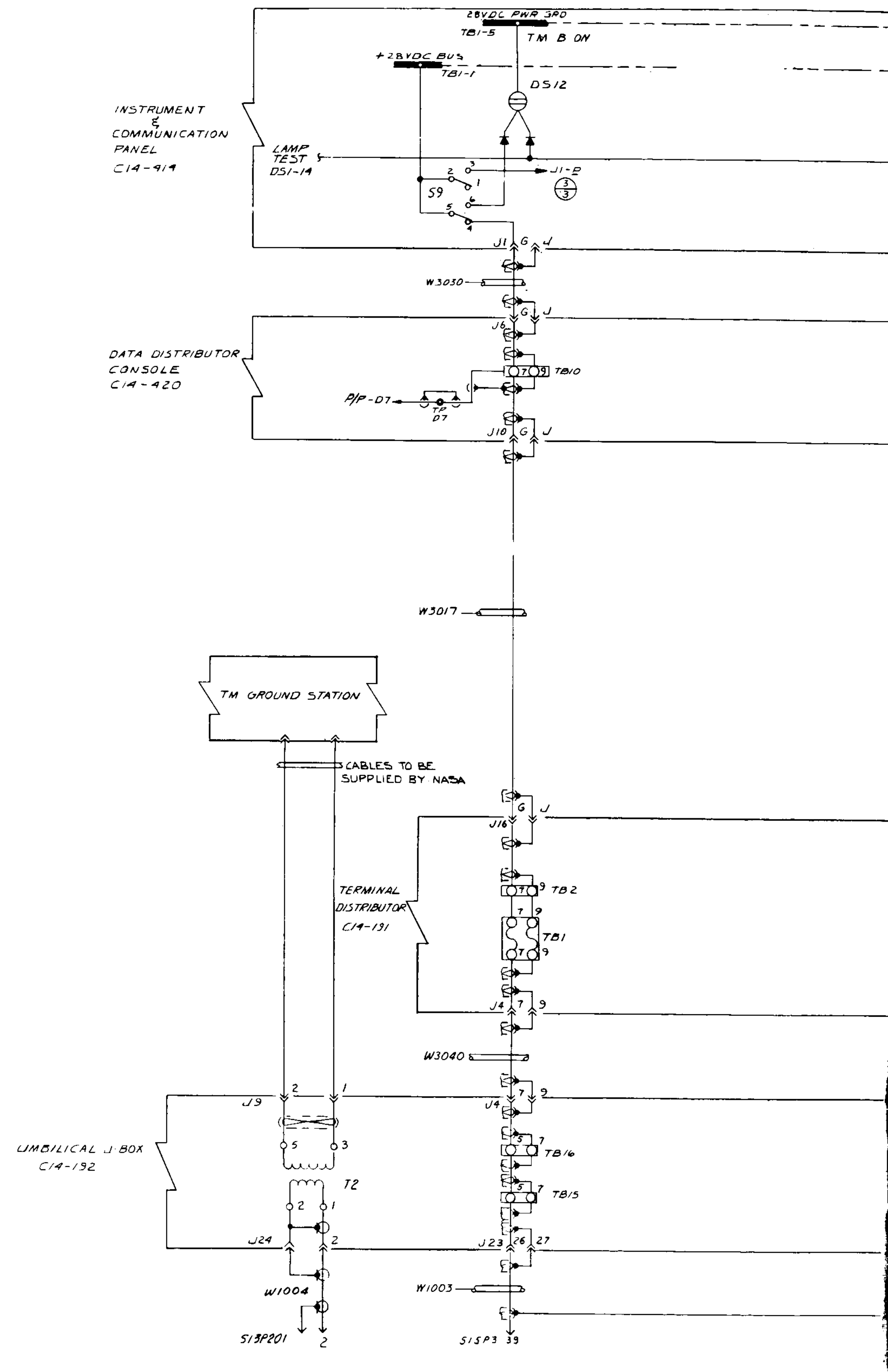


52 51 50 49

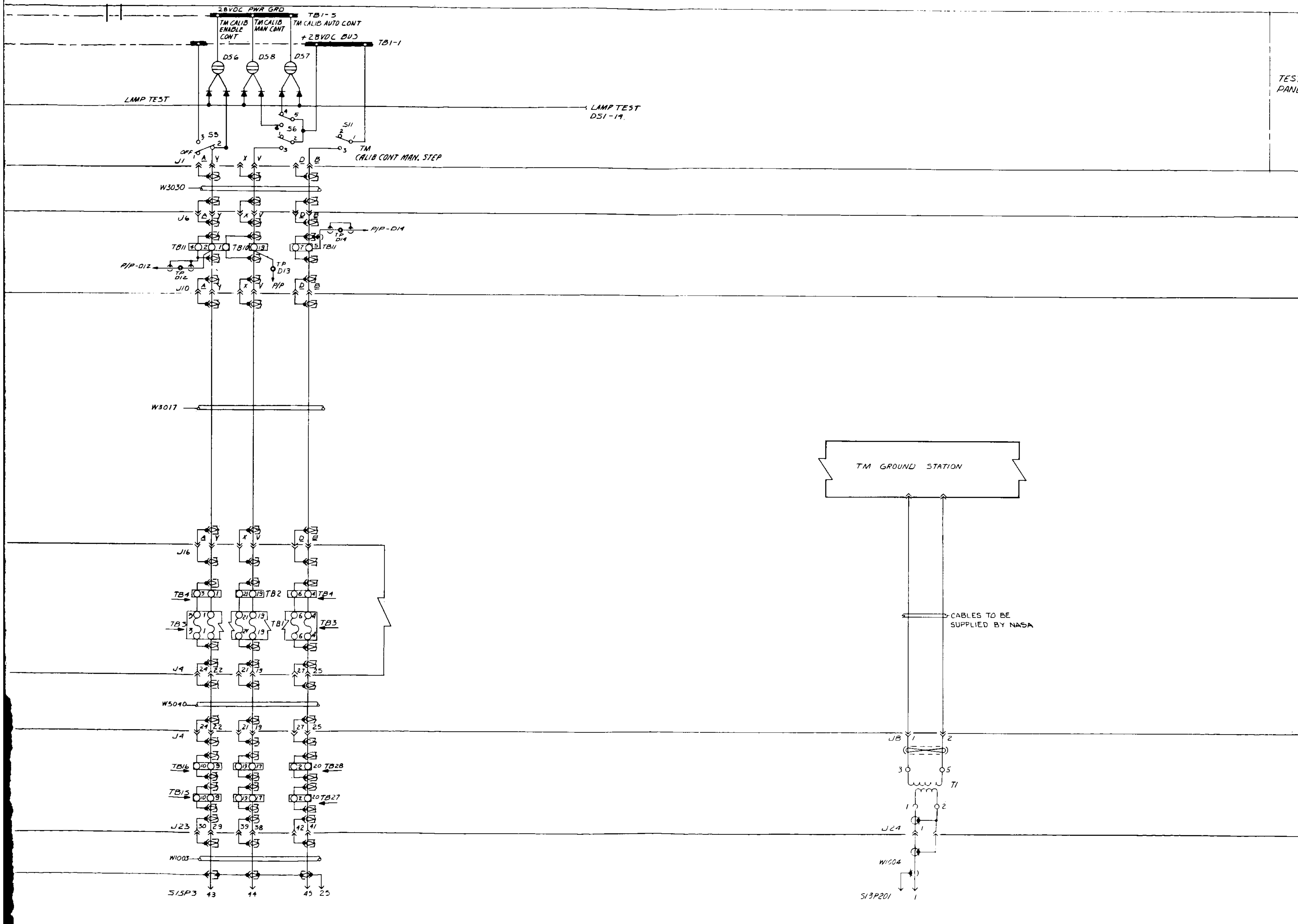
SM-4A-269B

Figure 8-2. GSE Combined Systems Schematic (Dwg G14-90004)
(Sheet 2 of 6)

3


28VDC PWR GRD
TB1-5
TM B ON
+28VDC BUS
TB1-1
DS12
INSTRUMENT & COMMUNICATION PANEL C14-414
LAMP TEST DS1-14
J1-B
S9
J1
G
J
W3030
J6
DATA DISTRIBUTOR CONSOLE C14-420
TB10
P/P-D7
TP D7
J10
W3017
TM GROUND STATION
CABLES TO BE SUPPLIED BY NASA
J16
TERMINAL DISTRIBUTOR C14-131
TB2
TB1
J4
W3040
J9
UMBILICAL J-BOX C14-192
T2
TB16
TB15
J24
J23
W1004
W1003
S13P201
S1SP3 39

48 47 46 45


28VDC PWR GRD
TB1-5
TM CALIB ENABLE CONT
TM CALIB MAN CONT
TM CALIB AUTO CONT
+28VDC BUS
TB1-1
DS6
DS8
DS7
LAMP TEST
LAMP TEST DS1-19.
S5
S6
S11
OFF
TM CALIB CONT MAN. STEP
J1
W3030
J6
TB11
TB10
P/P-D14
TP D14
P/P-D12
TP D12
TP D13
P/P
J10
W3017
TM GROUND STATION
J16
TB4
TB2
TB3
TB1
J4
W5040
TB16
TB28
TB15
TB27
J23
W1003
S15P3
CABLES TO BE SUPPLIED BY NASA
J8
T1
J24
W1004
S13P201
TES
PAN

44 43 42 41

2

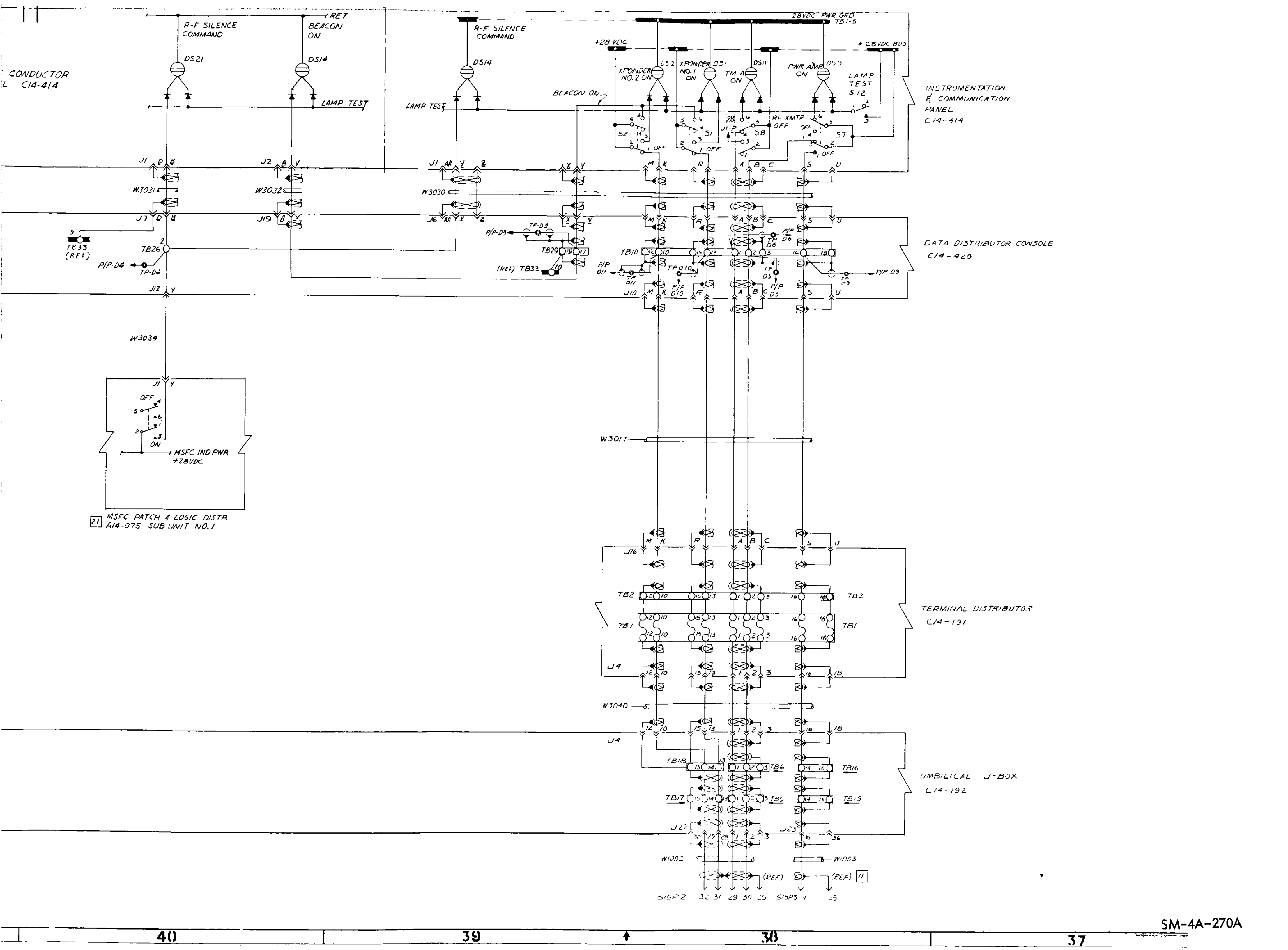
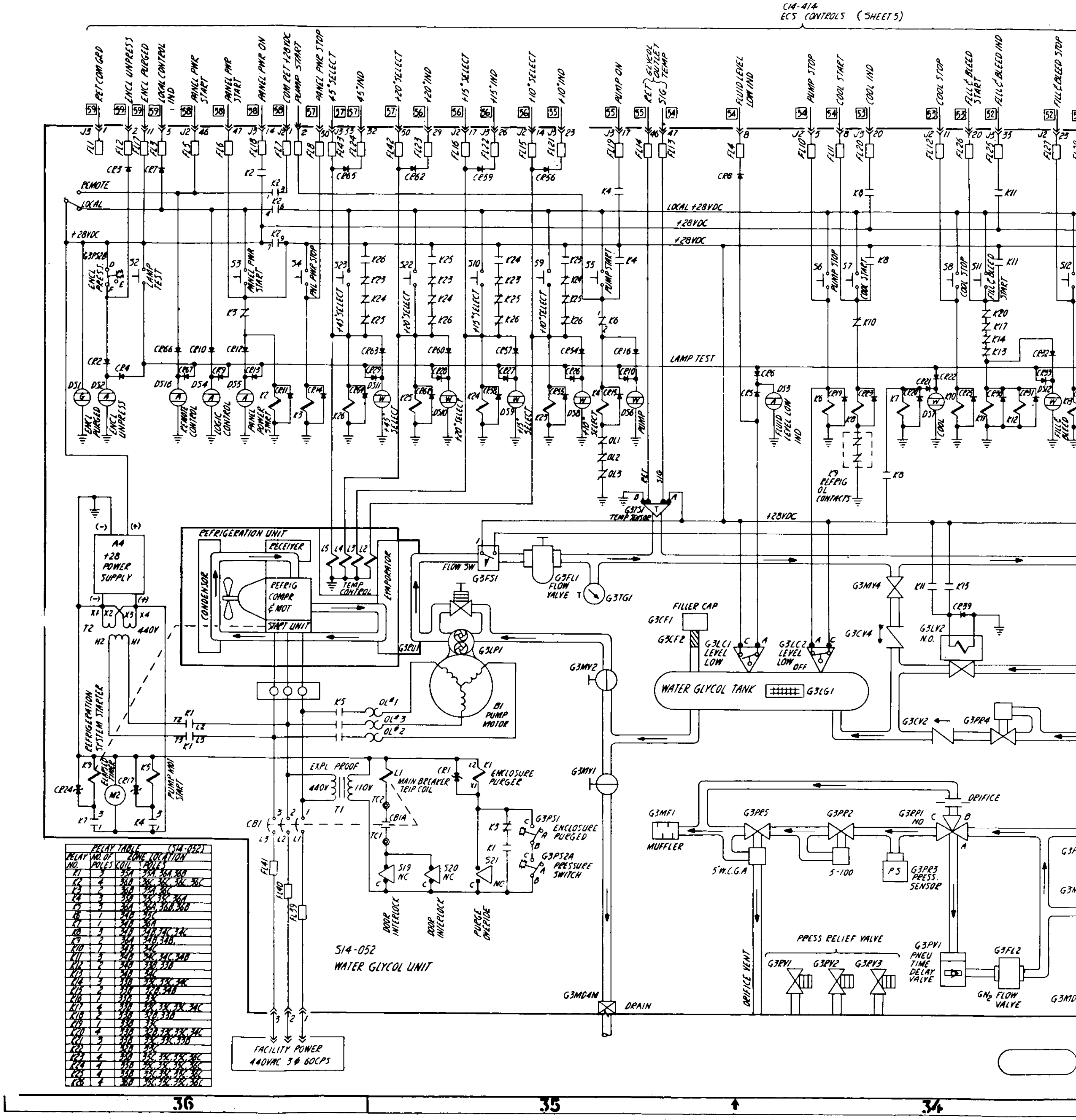
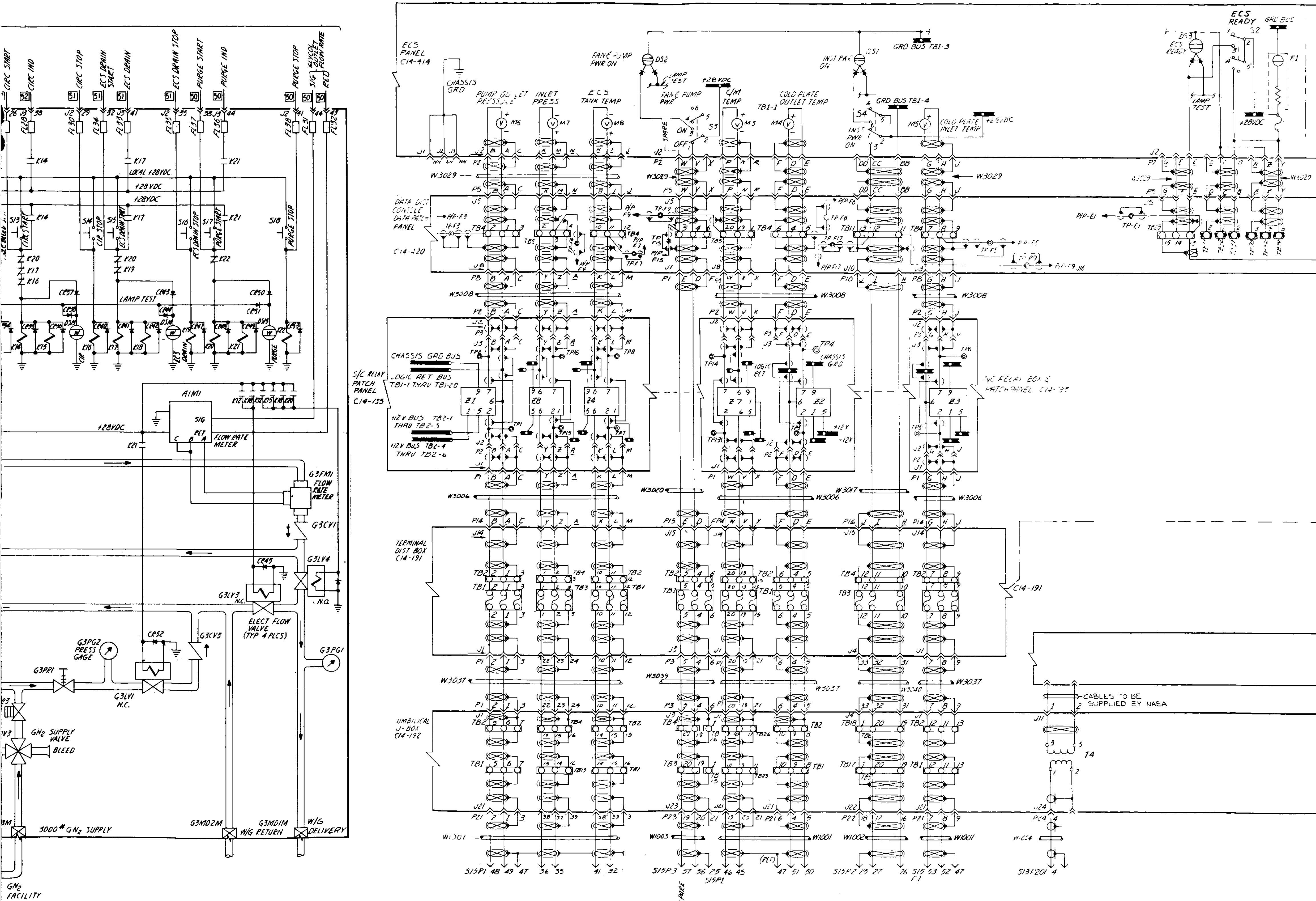


Figure 8-2. GSE Combined Systems Schematic (Dwg G14-90004) (Sheet 3 of 6)

3



RELAY TABLE (S14-052)			
RELAY NO.	NO. OF POLES	ZONE LOCATION COIL	ZONE LOCATION POLES
K1	3	35A	35A,36A,36B
K2	4	36B	36C,36C,36C,36C
K3	2	36B	35A,36C
K4	3	35B	35C,35C,36A
K5	3	36A	36A,36B,36B
K6	1	34B	35C
K7	1	34B	36A
K8	3	34B	34B,34C,34C
K9	2	36A	34B,34B.
K10	1	34B	34C
K11	3	34B	34C,34C,34B
K12	2	34B	33B,33B
K13	1	34B	34C
K14	3	33B	33C,33C,34C
K15	2	33B	32B,34B
K16	1	33B	33C
K17	4	33B	33C,33C,33C,34C
K18	2	33B	32B,33B
K19	1	33B	33C
K20	4	33B	32B,33C,33C,34C
K21	3	33B	33C,33C,33B
K22	1	34B	33C
K23	4	35B	35C,35C,35C,36C
K24	4	35B	35C,35C,35C,36C
K25	4	35B	35C,35C,35C,36C
K26	4	36B	35C,35C,35C,36C


ECS PANEL C14-414
DATA DIST CONSOLE DATA PATCH PANEL C14-420
S/C RELAY PATCH PANEL C14-135
TERMINAL DIST BOX C14-191
UMBILICAL J-BOX C14-192
CABLES TO BE SUPPLIED BY NASA
3000# GN_2 SUPPLY
GN_2 FACILITY
GN_2 SUPPLY VALVE
FLOW RATE METER
ELECT FLOW VALVE (TYP 4 PLCS)
W/G RETURN
W/G DELIVERY

33

32

31

30

2

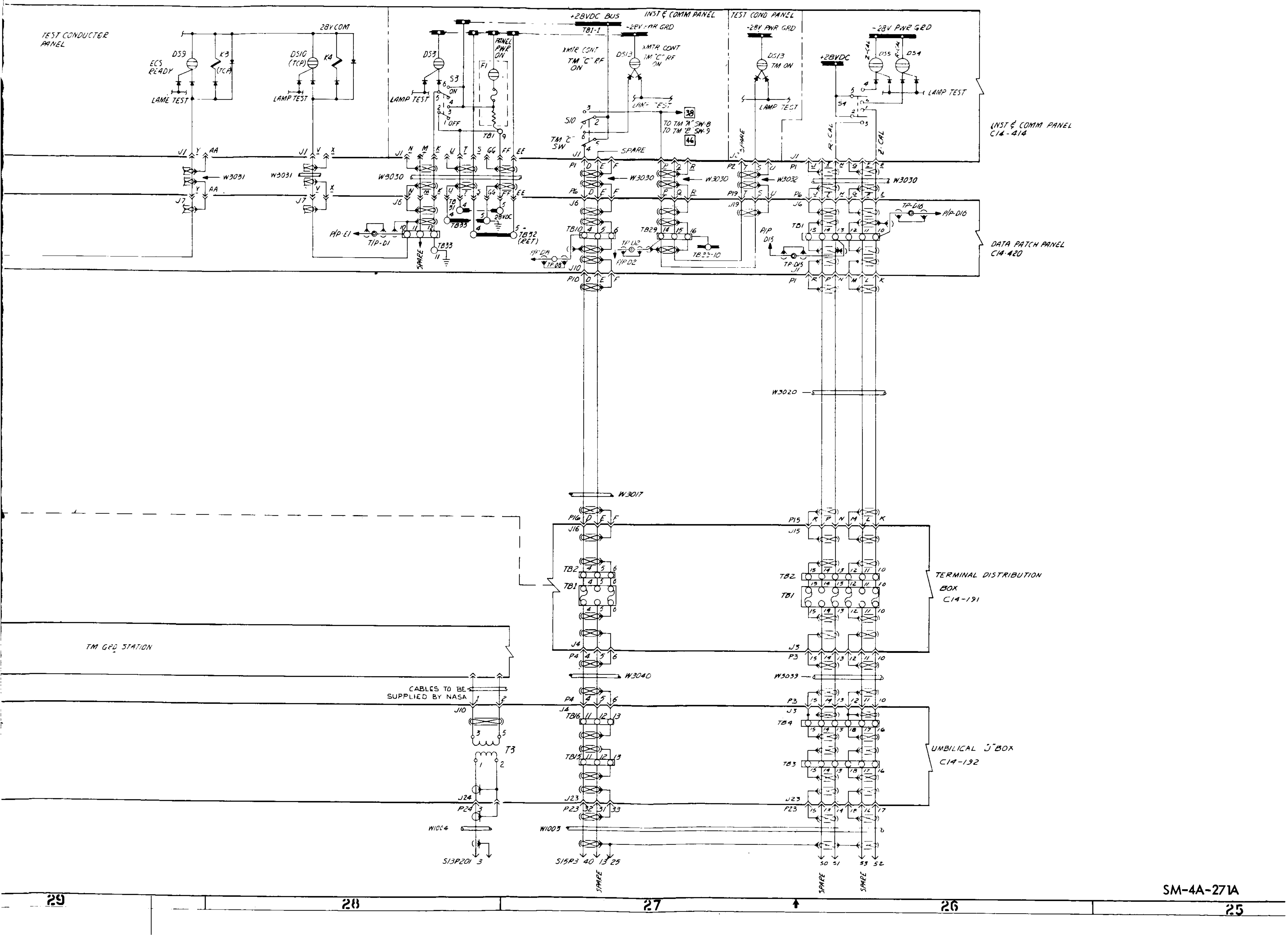
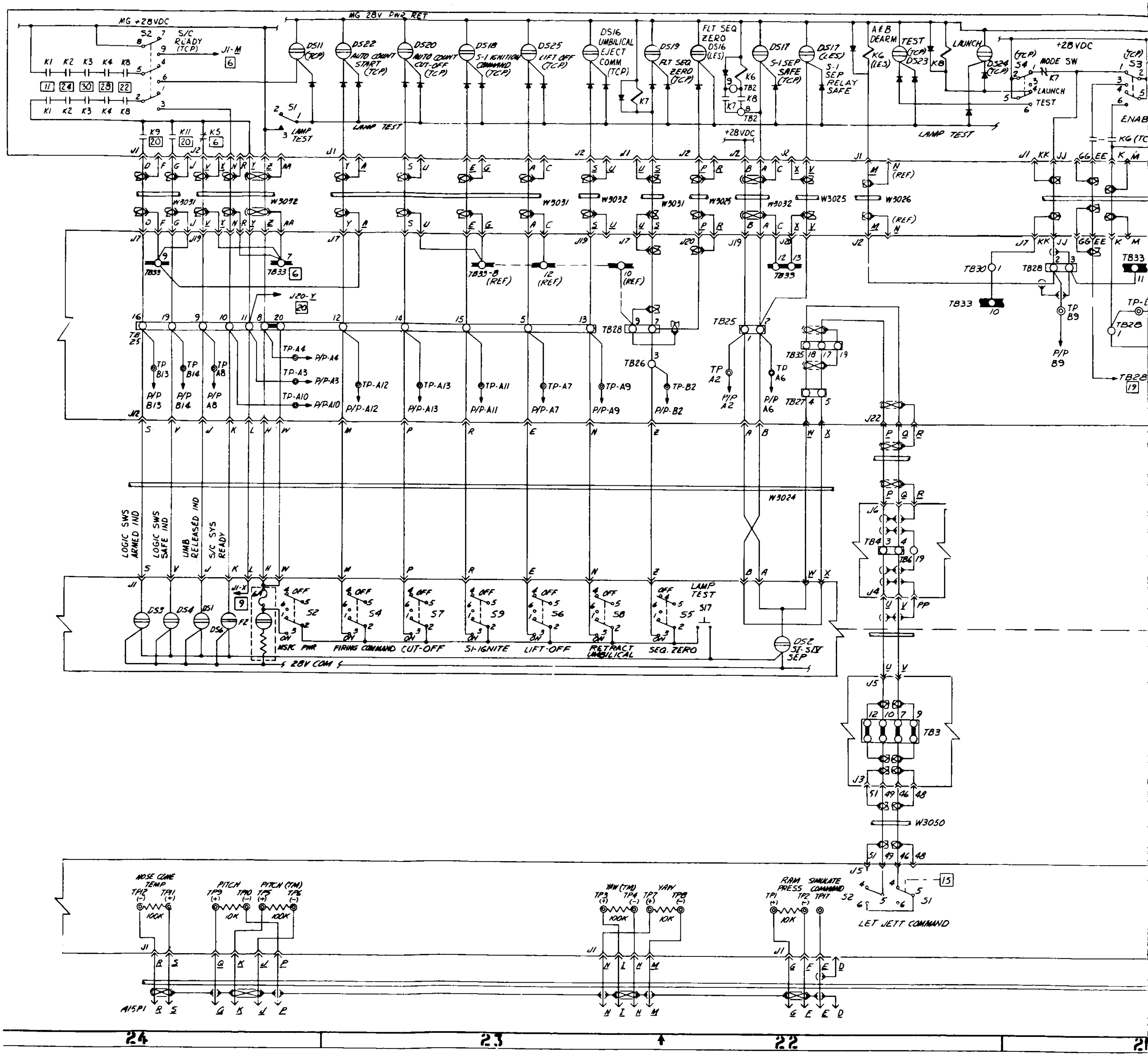
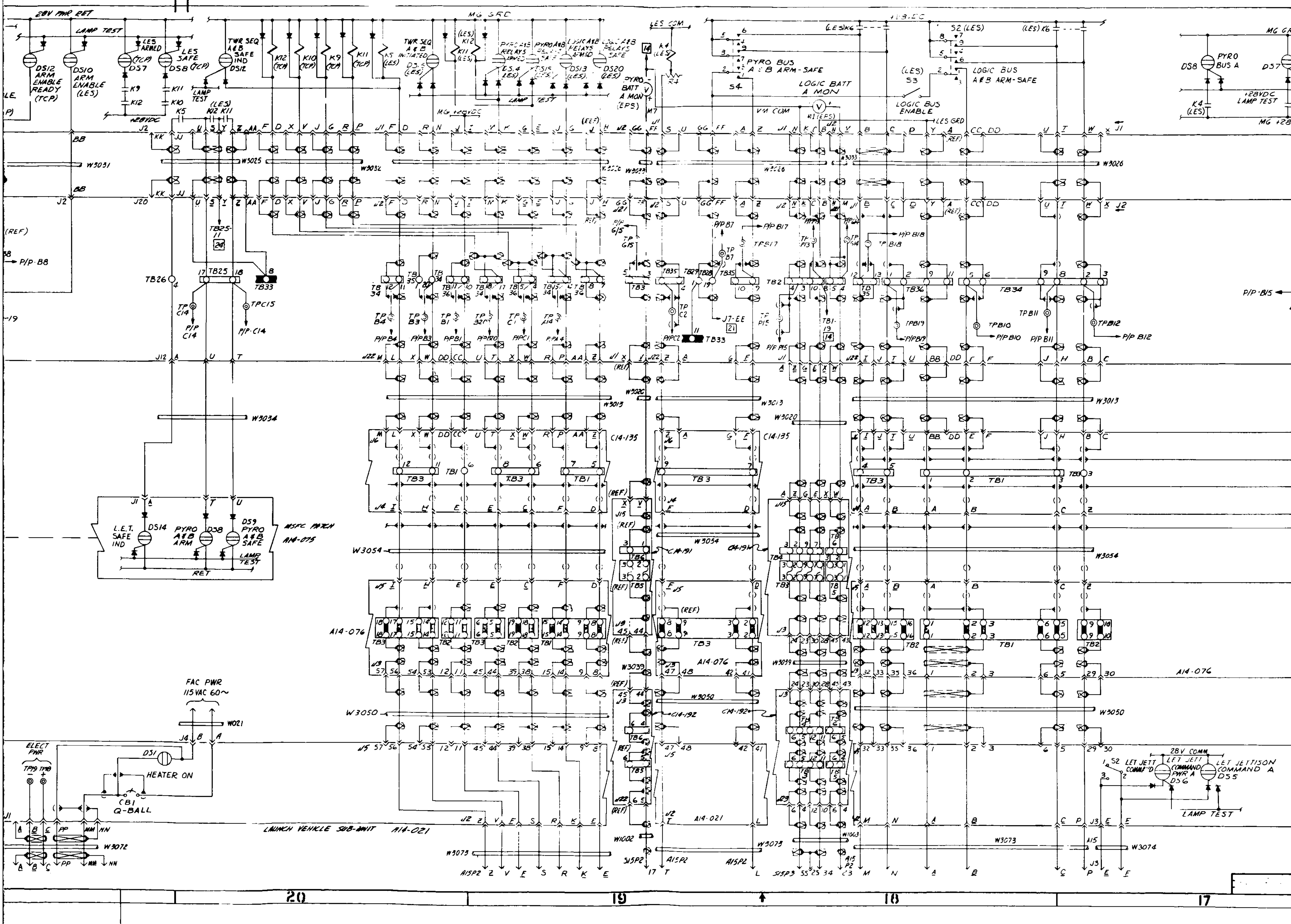


Figure 8-2. GSE Combined Systems Schematic (Dwg G14-90004)
(Sheet 4 of 6)

3


MG +28VDC
MG 28V PWR RET
S/C READY (TCP)
LAMP TEST
DS11 (TCP)
DS22 AUTO COUNT START (TCP)
DS20 AUTO COUNT CUT-OFF (TCP)
DS18 S-1 IGNITION COMMAND (TCP)
DS25 LIFT OFF (TCP)
DS16 UMBILICAL EJECT COMM (TCP)
DS19 FLT SEQ ZERO (TCP)
FLT SEQ ZERO DS16 (LES)
DS17 S-1 SEP SAFE (TCP)
DS17 (LES) S-1 SEP RELAY SAFE
A&B DEARM
TEST
LAUNCH
MODE SW
ENABLE
W3031
W3032
W3025
W3026
W3024
W3050
LOGIC SWS ARMED IND
LOGIC SWS SAFE IND
UMB RELEASED IND
S/C SYS READY
MSFC PWR
FIRING COMMAND
CUT-OFF
SI-IGNITE
LIFT-OFF
RETRACT UMBILICAL
SEQ. ZERO
S1-SIV SEP
28V COM
NOSE CONE TEMP
PITCH
PITCH (TM)
YAW (TM)
YAW
RAM PRESS
SIMULATE COMMAND
LET JETT COMMAND
A15P1
24
23
22
21


28V PWR RET
LAMP TEST
DS12 ARM ENABLE READY (TCP)
DS10 ARM ENABLE (LES)
LES ARMED
DS7
LES SAFE
DS8
TWR SEQ A&B SAFE IND
DS12
MG GRD
TWR SEQ A&B INITIATED
PYRO A&B RELAYS ARMED
LOGIC A&B RELAYS ARMED
LOGIC A&B RELAYS SAFE
DS13
DS20
LES COM
PYRO BATT A MON (EPS)
PYRO BUS A&B ARM-SAFE
LOGIC BATT A MON
VM COM
S4
S2 (LES)
(LES) K6
LOGIC BUS A&B ARM-SAFE
LOGIC BUS ENABLE
LES GRD
S3
PYRO BUS A
+28VDC LAMP TEST
W3031
W3025
W3032
W3026
W3033
TB25
TB26
TB33
TB34
TB36
TB35
TB2
TB1
TB3
W3034
W3013
W3020
C14-135
W3054
C14-191
W3050
C14-192
W3039
A14-076
A14-075
MSFC PATCH
L.E.T. SAFE IND
DS14
PYRO A&B ARM
DS38
DS39 PYRO A&B SAFE
RET
FAC PWR 115VAC 60~
W021
DS1
HEATER ON
CB1 Q-BALL
ELECT PWR
W3072
LAUNCH VEHICLE SUB-UNIT A14-021
W3073
W3074
W1002
W1003
A14-021
LET JETT COMM'D
LET JETT COMMAND PWR A
DS6
LET JETTISON COMMAND A
DS5
28V COMM
P/P B15
20
19
18
17

2

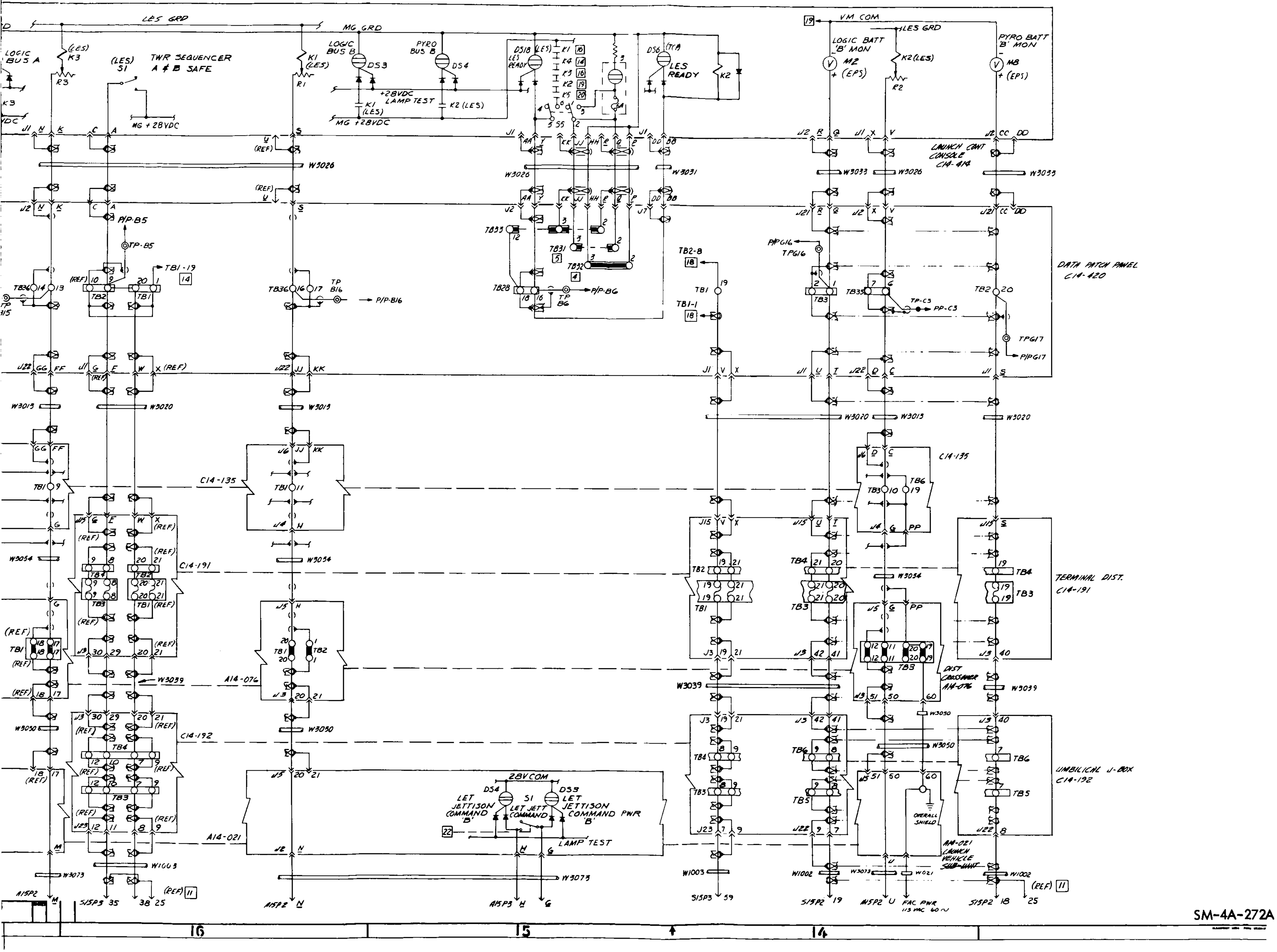
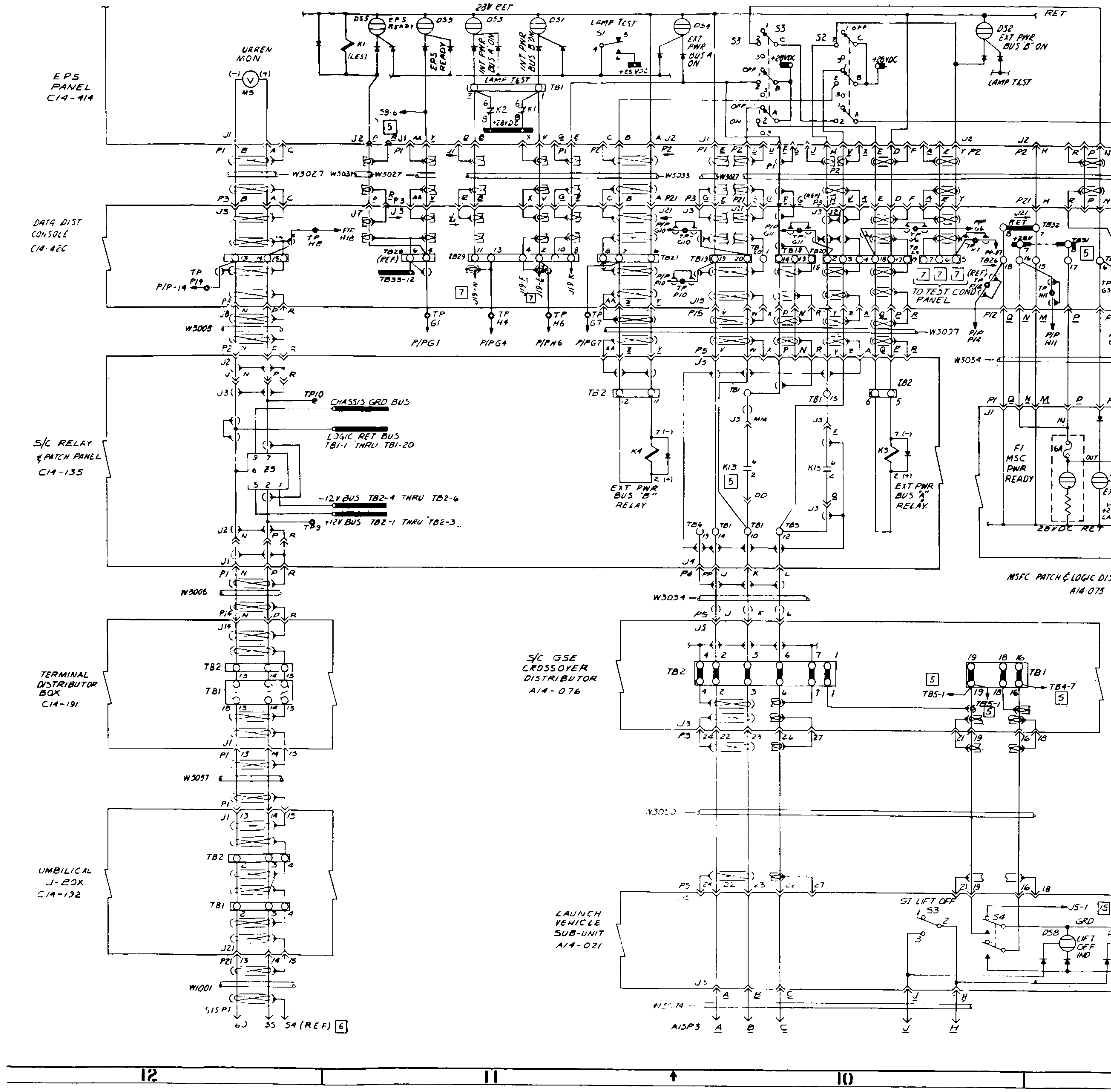
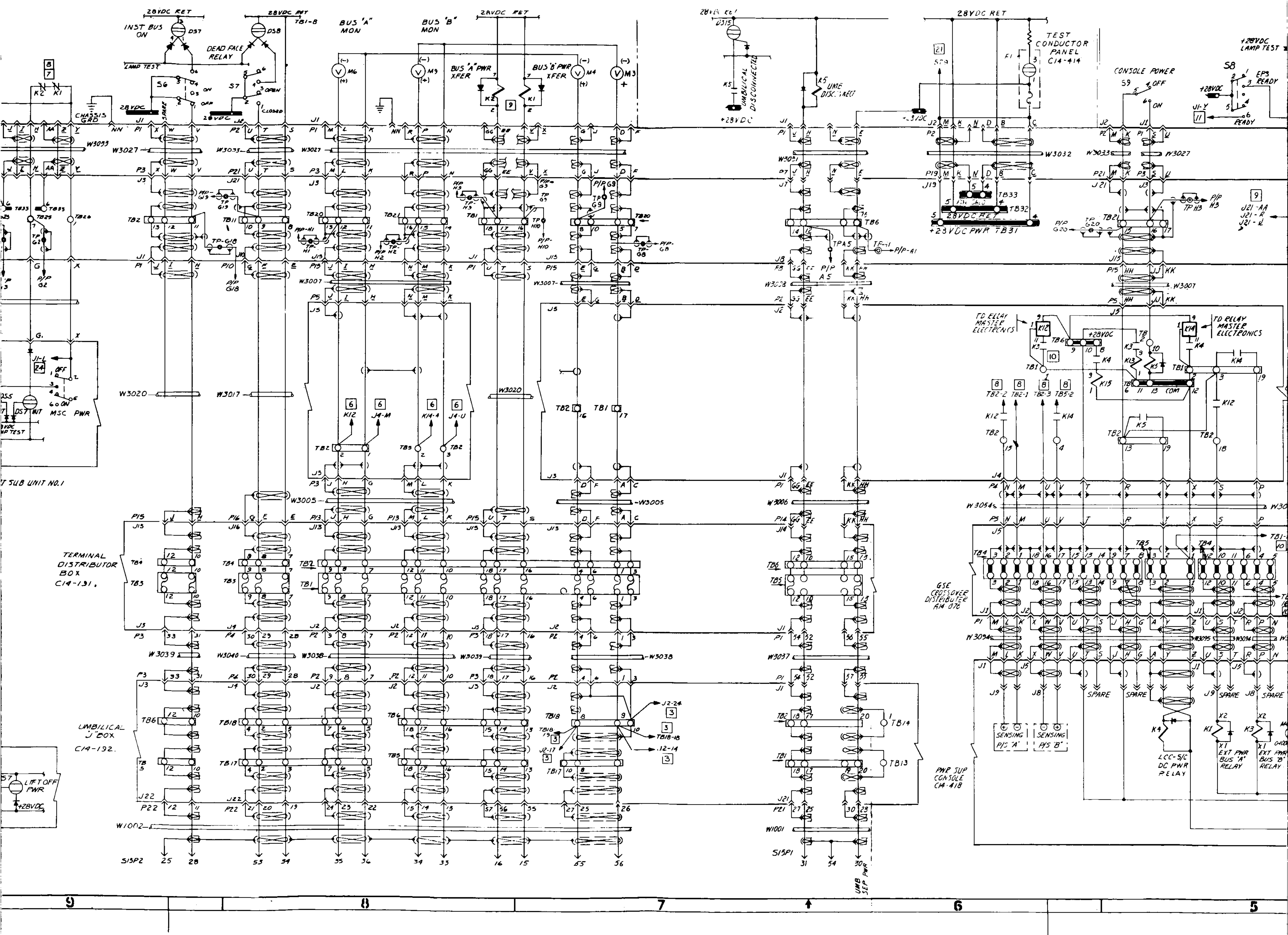


Figure 8-2. GSE Combined Systems Schematic (Dwg G14-90004) (Sheet 5 of 6)

3



EPS PANEL C14-414
DATA DIST CONSOLE C14-42C
S/C RELAY & PATCH PANEL C14-135
TERMINAL DISTRIBUTOR BOX C14-191
UMBILICAL J-BOX C14-132
S/C GSE CROSSOVER DISTRIBUTOR A14-076
LAUNCH VEHICLE SUB-UNIT A14-021
MSFC PATCH & LOGIC DI
A14-075
28V RET
LAMP TEST
EPS READY
INT PWR BUS A ON
INT PWR BUS B ON
EXT PWR BUS A ON
EXT PWR BUS B ON
CHASSIS GRD BUS
LOGIC RET BUS TB1-1 THRU TB1-20
-12V BUS TB2-4 THRU TB2-6
+12V BUS TB2-1 THRU TB2-3
EXT PWR BUS "B" RELAY
EXT PWR BUS "A" RELAY
TO TEST COND PANEL
F1 MSC PWR READY
S1 LIFT OFF
LIFT OFF IND
12
11
10


28VDC RET
INST BUS ON
DS7
DS8
DEAD FACE RELAY
LAMP TEST
S6
S7
CHASSIS GRD
BUS "A" MON
BUS "B" MON
BUS "A" PWR XFER
BUS "B" PWR XFER
M6
M9
M4
M3
UMBILICAL DISCONNECTED
UMB DISCONNECT
+28VDC
TEST CONDUCTOR PANEL C14-414
CONSOLE POWER
S9
OFF
ON
S8
+28VDC LAMP TEST
EPS READY
MSC PWR
W3020
W3017
W3027
W3033
W3007
W3005
W3032
W3054
W3039
W3040
W3038
W3037
W1002
W1001
TERMINAL DISTRIBUTOR BOX C14-131.
UMBILICAL "J" BOX C14-192.
LIFT OFF PWR
SUB UNIT NO. 1
28VDC RET TB32
+28VDC PWR TB31
TB33
TD RELAY MASTER ELECTRONICS
GSE CROSSOVER DISTRIBUTER A14-070
PWR SUP CONSOLE C14-418
SENSING P/S "A"
SENSING P/S "B"
SPARE
LCC-S/C DC PWR RELAY
EXT PWR BUS "A" RELAY
EXT PWR BUS "B" RELAY
S15P2
S15P1
UMB SEP PWR
9
8
7
6
5

2

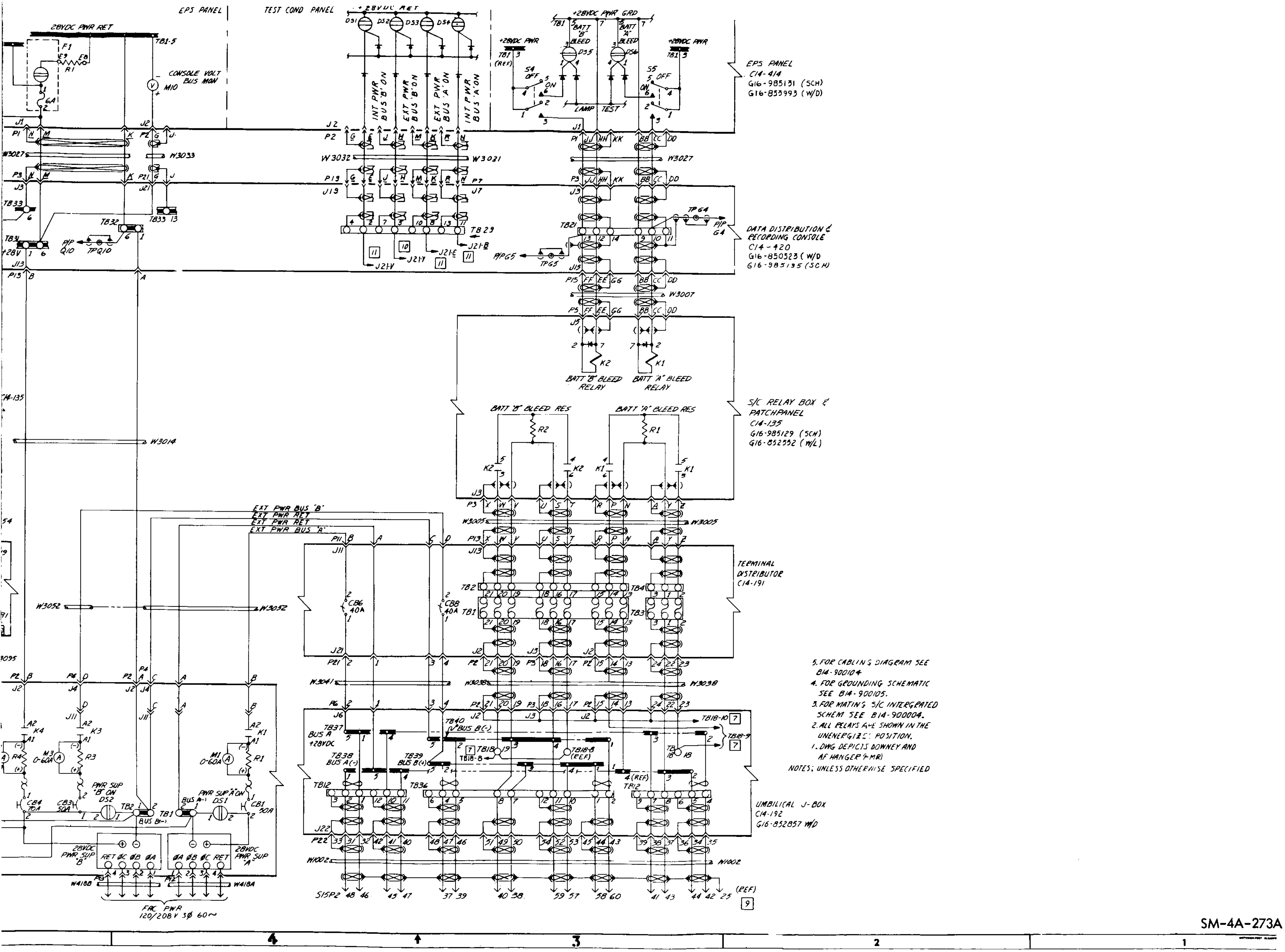


Figure 8-2. GSE Combined Systems Schematic (Dwg G14-90004)
(Sheet 6 of 6)

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